Tucson Plant Materials Center

2007 Annual Technical Report

USDA
Natural Resources Conservation Service

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Introduction

The Tucson Plant Materials Center (TPMC) is operated by the USDA-Natural Resources Conservation Service. In 1935 the USDA-Natural Resources Conservation Service recognized the need for adapted plant material for use in their conservation programs. This need was addressed by the establishment of plant materials nurseries in critical areas throughout the United States. The Plant Materials program has grown into a network of 27 centers throughout the United States. The Tucson Plant Materials Center (Tucson PMC) was one of the initial centers established to provide adapted plant material for conservation programs in the southwest United States. Over the past 70 years the Tucson PMC has developed and evaluated plant materials and technologies for their establishment that have enhanced conservation efforts throughout its service area.

The Tucson PMC service area supports the Sonoran, Mohave and Chihuahuan desert regions. Plant Material products and support is provided to areas within the states of Arizona, California, Nevada, Utah, and New Mexico. The Tucson PMC works closely with its customers to provide effective, cost-efficient vegetative solutions for conservation problems. Rangelands, mined lands, critical areas, urban and urban interface areas, riparian areas, croplands, water and air quality, invasive species, and wildlife habitat all present resource issues within the PMC service area.

The PMC evaluates the conservation potential of native grasses, shrubs, Forbs and trees at the federally owned 45-acre farm in Tucson, Arizona. Selected plant materials become part of advanced trials designed to develop cultural and management practices that enhance seed production and ease of establishment in their native plant communities or environments. These practices, along with efficiency and adaptability, are assessed using field plantings at selected test sites throughout the PMC service area.

The Tucson PMC works in partnership with NRCS field offices, resource conservation and development (RC&D) groups, conservation districts, federal and state agencies, non-profit groups and private landowners to develop improved resource technology. Cooperation with agencies and groups other than NRCS provides opportunities for the joint development of plant materials and management practices as well as for exchange of information, seed, and planting stock.

This publication provides information on studies and activities carried out at the PMC during 2007.

Summary of 2007 Weather Conditions at the Tucson Plant Materials Center Tucson, Arizona

Month	Temperature (^{o}F)		Precipitation (inches)
	Maximum	Minimum	
January	78	21	0.65
February	82	32	0.77
March	97	32	0.58
April	93	45	0.39
May	102	50	0.00
June	108	60	0.05
July	107	69	2.33
August	111	71	1.49
September	104	58	0.70
October	99	44	0.52
November	88	28	0.04
December	78	28	0.58
	Avg. 84	Avg. 56	Total 8.10

Frost Free Days = 349

Days Above 100 ^{o}F = 71

Coldest Temperature = January 15th 21 ^{o}F

Hottest Temperature = July 21st 114 ^{o}F

1st day 100 ^{o}F = May 11th

1st day 32 ^{o}F = November 30th

Bush Muhly Technology Development

STUDY NUMBER: AZPMC-T-0502-CR

Introduction

Bush muhly (*Muhlenbergia porteri* Scribn. Ex Beal.) is a warm season native perennial bush grass. Plants may reach up to 3 feet (1 m) in height and are highly branched. It occurs in desert grasslands, desert shrub, within interior chaparral and it is an understory component of evergreen woodlands. Distribution occurs from the southern Great Basin and Intermountain region south to California, Texas and Mexico. Bush muhly originally existed in extensive stands. It can be very susceptible to winter grazing and likely has retreated to areas where it is protected from grazing by shrubs. When bush muhly has sufficient moisture it does not die back to the root crown in winter, and new growth starts from near the base of the previous year's stems.

Materials and Methods

Transplants of bush muhly were grown in 5.7 cu. in. containers in the lathhouse at the PMC (Table 1). Six rows were established in a small border in September of 2005. The border was fertilized with 200 lbs/acre of ammonium sulfate (21-0-0) prior to planting. After plants had established the pre-emergent herbicide Oryzalin was applied.

When mature, this planting will be used to evaluate cultural practices related to seed yield, harvesting and seed processing. Bush muhly is a very desirable species for field plantings but is very expensive from commercial dealers. By investigating cultural practices involved in seed production, the price of this species will undoubtedly decrease, and increase its availability to the market.

Table 1. Accession number and collection location of 22 accessions in Bush muhly evaluation

Number	Accession Number	Collection Location	Number	Accession Number	Collection Location
1	9063997	-109.8041 31.3439	12	9064002	-113.3921 36.6943
2	9058830	-110.4192 33.5026	13	9092495	-109.7999 32.9979
3	9058798	-115.1658 37.4003	14	9092493	-109.8387 32.7485
4	9058796	-110.9347 32.4314	15	9058823	-110.0478 32.8528
5	9053587	-114.1672 33.0667	16	9058824	-110.0306 32.8239
6	9058822	-109.8597 32.8961	17	9058799	-111.5551 31.9883
7	9092494	-109.8482 31.7219	18	9058829	-110.4538 33.5026
8	9058801	-109.4328 32.6075	19	9058826	-109.1768 32.6940
9	9058763	-111.7583 31.7083	20	9058828	-113.3742 36.7088
10	9058800	-111.3772 31.8775	21	9058797	-111.8861 32.7172
11	9058825	-109.1611 33.0125	22	9058821	-111.6917 32.1972

Location of Collections in the Bush Muhly Technology Development Study

Development of Technology for Seed Production of 'Stevan' Plains Bristlegrass

STUDY NUMBER: AZPMC-T-0405-CR
STUDY NUMBER: AZPMC-S-0702-CP

Introduction

Plains bristlegrass [*Setaria leucopila* (Scribn. & Merr.) K. Schum.] is a very desirable grass for restoration, providing good grazing for livestock and wildlife. 'Stevan' plains bristlegrass was released by the Tucson Plant Materials Center in 1994. 'Stevan' was selected for vigor and forage production. New plantings of 'Stevan' produced quality seed; however as the plantings aged seed fill reduced significantly. 'Stevan' was removed from production at the PMC because seed fill was extremely poor. The fact that young plantings of 'Stevan' produced viable seed indicates that the poor seed fill is not an intrinsic problem, but a cultural one. The objective of this study is to develop cultural practices for good seed production in plains bristlegrass.

Description

Plains bristlegrass is widespread and abundant in southern Arizona. It occurs at elevations from 2,000 to 7,000 feet (610 to 2,134 m). It is found growing in dry plains and washes, on rocky slopes, and often in partial shade of shrubs and trees.

Plains bristlegrass is a native, perennial, C_4, warm season bunchgrass. Culms are 16 to 47 inches (40 to 120 cm) tall, firm, wiry and bent sharply. The lower nodes are usually pubescent to hairy. The sheath is ciliate on the margins and with a tuft of hair on either side of the ligule. The ligule has a fringe of straight, stiff hairs. The panicle is dense and spikelike, 2 to 6 inches (5 to 15cm) long.

Materials and Methods

Thirteen accessions (Table 1) were planted in an initial evaluation planting (IEP) and observed from 1975-1979 and no significant differences were observed. Seed from the 13 accession were blended to form the composite 'Stevan' (accession 9003939).

To re-establish ‘Stevan’ Plains bristlegrass transplants were grown in 5.7 cu. in. containers in the lathhouse at the PMC. Four rows were established in a small border in September of 2004. The border was fertilized with 200 lbs/acre of ammonium sulfate (21-0-0) prior to planting. After plants had established the pre-emergent herbicide Oryzalin was applied.

This planting continues to be evaluated for cultural practices with the potential to increase the seed viability and yield. This release continues to have low germination rates using traditional germination testing. In spring 2007, three separate harvest years 2003, 2005 and 2006 were tested for germination in containers in the greenhouse. Three replications of 100 seed per pot were planted in 5”x3” pots with 2” of potting soil. Very few seeds germinated in any of the lots. This release will continue to be tested in greenhouse experiments and field plantings to determine its true germination potential.

The TPMC well was down for repair from July 1, 2007 until October 25, 2007. This planting may have been damaged by lack of water and will be evaluated in 2008 to determine if it will need to be replanted.

Table 1. Accession number and collection location of accessions used in the composite cultivar ‘Steven’.

	Accession Number	**Collection Location**		**Accession Number**	**Collection Location**
1.	A-14266	Wilcox, AZ	8.	A-18173	Klondyke, AZ
2.	A-14539	Montezumas Well, AZ	9.	A-18174	Sasabe, AZ
3.	A-16535	Odessa, TX	10.	A-18176	Douglas, AZ
4.	A-17004	NM	11.	A-18294	Odessa, TX
5.	A-18170	Bowie, AZ	12.	A-18309	Douglas, AZ
6.	A-18171	Willow Springs Ranch, AZ	13.	A-18312	Klondyke, AZ
7.	A-18172	Tucson, AZ			

Literature

1. Flora of North America Editorial Committee, eds. 2003. Flora of North America North of Mexico. Vol 25. New York and Oxford.
2. Gould, Frank W. 1977. Grasses of Southwestern United States. University of Arizona Press, Tucson, Arizona. pp.270-271.
3. Pater, Mark. 1994. Notice of Naming and Release of ‘Stevan’ Plains Bristlegrass (*Setaria leucopila*). USDA, Soil Conservation Service, Tucson, Arizona. June 1994. 14p.
4. Tapia, C.R. and E.M. Schmutz. 1971. Germination responses of three desert grasses to moisture stress and light. Jour. of Range Mgmt. 24:292-295.
5. Toole, V.K. 1941. Germination of seed of vine-mesquite, *Panicum obtusum*, and plains bristle-grass, *Setaria macrostachya*. Jour. Amer. Soc. Agron. 32:503-512.

6. USDA, Soil Conservation Service. 1984 Technical Guide, Section IV, Range Seeding Specifications. USDA, Soil Conservation Service, Phoenix, Arizona. Revised January 1984.
7. USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

Development of Technology for Seed Production of 'Sonora' Black Grama

STUDY NUMBER: AZPMC-T-0503-CR

Description

Black grama is a long lived native perennial grass. It is an important native range grass of the semiarid and arid desert rangelands of the southwest. Distribution stretches from Texas to southern California and from Mexico northward to Colorado, Wyoming and Utah. It has wiry, spreading stems reaching 8 to 24 inches (20 to 60 cm). The growth habit of black grama varies among regions, being primarily caespitose in some areas and to stoloniferous in others. Leaves are smooth, narrow, flexuous and mostly basal. Leaf blades are 1 to 3 inches (2 to 7 cm) long and 0.08 to 0.02 inches (0.5 to 2 mm) wide. The inflorescence is a panicle consisting of 3 to 8 spicate unilateral branches.

The primary mode of regeneration for black grama is through tilling and stoloniferous expansion. Black grama regeneration through seed is often sparse. In most years less than 20 percent of black grama florets produce viable seed. This poor seed set has been attributed to insect infestation. Insects collected from black grama stands from 1957 through 1960 included representatives from nine orders, 55 families, 109 genera and 120 species of insects. Control of insects may result in an up to 700% increase in florets that produce mature caryopsis.

Black grama once occurred in almost pure stands over extensive areas of southeastern Arizona, southern New Mexico, western Texas and into northern Mexico. Due to human and natural factors these stands are now far less extensive. The fact that black grama's primary reproduction is asexual means that existing stands of black grama spread slowly into adjacent areas. Black grama has not generally been used for reseeding because of characteristic poor seed production and scarcity of quality seed.

'Sonora' black grama [*Bouteloua eriopoda*(Torr.) Torr.] was released by the Tucson PMC in 1965. It was the first improved black grama cultivar to be released for commercial seed production. The cultivar was developed from 11 vegetative and 47 seed accessions collected from Arizona and New Mexico in 1957. At the time of release 'Sonora' was characterized as outstanding for leafiness, vigor, forage production, vegetative spread, seed set and seed production. However, seed production in subsequent years declined and 'Sonora' was abandoned due to poor seed yield. Subsequent research has provided information indicating that the reduction in seed yield was due to a build up of parasitic insects.

A 0.25 acre production field was reestablished at the PMC in 2005 to determine if agronomic and pesticide protocols could be developed that would make 'Sonora' a viable cultivar for southern Arizona and New Mexico.

Transplants were grown in 5.2 cu. in. forestry pellets and transplanted in September with a mechanical transplanter. The border was fertilized with 200 lbs/acre of ammonium sulfate (21-0-0) prior to planting. Following harvest, this planting will be used to evaluate cultural practices and insecticide treatments to determine if production of 'Sonora' is economically viable.

Literature

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Demonstration of Native Grasses

STUDY NUMBER: AZPMC-T-0301-CR

Introduction

A grass demonstration nursery was established at the Tucson Plant Materials center in 2003. This nursery consists of warm and cool season native plant material (Table 1). The nursery consists of Plant Material Program Releases adapted or presently used for plantings. This nursery is used for training and for informal evaluation.

Table 1. Plant Materials Releases in the Native Grass Demonstration Nursery

Common Name	Scientific Name	Release Name	Origin
Eastern Gamagrass	*Tripsacum dactyloides*	'Pete'	KSPMC
Indian Ricegrass	*Achnatherum hymenoides*	'Rimrock' 'Nezpar' 'Paloma'	MTPMC IDPMC NMPMC
Green Sprangletop	*Leptochloa dubia*	'Marfa'	TXPMC
Bottlebrush Squirreltail	*Elymus elymoides*	'Tusas' 'Sandhollow'	NMPMC ARSUT
Galleta Grass	*Pleuraphis jamesii*	'Viva'	NMPMC
Sand Bluestem	*Andropogon halli*	'Elida' 'Garden'	NMPMC KSPMC
Sideoats Grama	*Bouteloua curtipendula*	'Haskel' 'Vaughn' 'Niner'	TXPMC NMPMC NMPMC
Spike Dropseed	*Sporobolus contractus*	Potter County Germplasm	TXPMC
Arizona Cottontop	*Digitaria californica*	'Loetta'	AZPMC
Arizona Fescue	*Festuca arizonica*	'Redondo'	NMPMC
Switchgrass	*Panicum virgatum*	'Alamo' 'Kanlow' 'Blackwell'	TXPMC KSPMC KSPMC
Little Bluestem	*Schizachyrium scoparium*	'Cimmaron'	KSPMC
Blue Grama	*Bouteloua gracilis*	'Alma' 'Hachita'	NMPMC NMPMC
Big Bluestem	*Andropogon gerardii*	'Earl'	TXPMC
Alkali Sacaton	*Sporobolus airoides*	'Saltalk'	TXPMC
Cane Bluestem	*Bothriochloa barbinodis*	Saltillo Germplasm Grant Germplasm	AZPMC NMPMC
Sand Dropseed	*Sporobolus cryptandrus*	Borden County Germplasm	TXPMC
Black Grama	*Bouteloua eriopoda*	'Nogal' 'Sonora'	NMPMC AZPMC
Sand Lovegrass	*Eragrostis trichodes*	'Mason'	TXPMC
		'Bend'	KSPMC

Seed from each species were sown into cone-tainers (SC-10 super cells) in the greenhouse in March 2003. Each species was watered and fertilized as needed. In June the plants were transplanted to the field. Plants were planted in single rows 50 feet long with 40 inches between the rows. Material of the same species were planted adjacent to each other. The planting was fertilized with 100 lbs/acre of urea (46-0-0). Water was applied immediately after fertilization to prevent volitization of the urea as ammonia. After plants were established the pre-emergent herbicide Oryzalin was applied to prevent weeds and seedlings from the plants. Oryzalin is re-applied at 6 month intervals. The planting is watered and cultivated as needed. They are mowed 2 times per year.

Cool Season Grasses

None of the cool season grasses planted thrived and most did not survive the southern Arizona summer. Cool season grasses are not typically included in seeding mixes for southern Arizona. However, many land managers have expressed interest in including them in mixes at elevations above 2500 feet.

Bottlebrush squirreltail:

Tusas germplasm is superior to Sandhollow germplasm in this planting. The Sandhollow germplasm plants all died before September 2003. They did not survive the summer. Approximately 20% of the Tusas germplasm plants survived and produced seed in spring 2004. The surviving plants remained in 2005. In 2006 all plants have perished.

Indian ricegrass:

The cultivar 'Paloma' appears to be the better choice for southern Arizona. Even though it is very stressed by the summer heat, it continues to survive and produce seed. Neither 'Nezpar' nor 'Rimrock' survived the first summer. No plants of 'Paloma' survived through 2006

Warm Season Grasses

All warm season grasses have survived. The Eastern gamagrass seems to be perpetually chlorotic, probably due to the high soil pH. Big bluestem, sand bluestem and sand lovegrass are all struggling, but are surviving.

Sideoats grama:

'Vaughn' sideoats appears to be superior to 'Haskell' and 'Niner', as it is much more vigorous, and produces more vegetation. Haskell is gradually disappearing from the study, with only a few plants remaining in 2006. In 2007 all sideoats stands are declining.

Switchgrass:

All switchgrass cultivars are thriving. 'Alamo' produces the

Switchgrass Cultivars in 2004

bigger plants.

Sand bluestem:

'Elida' is the more vigorous cultivar under the conditions of this trial. However, by 2006 most plants have disappeared. In 2007 only a few remnant plants remain.

Cane bluestem:

The cane bluestem germplasm Saltillo and Grant appear very similar. The Saltillo germplasm greens up approximately 2 weeks before Grant, however Grant produces more vegetation. In 2006 it appears that the Grant germplasm stand is thinning. The Saltillo stand is still strong. Observations in 2007 are similar to 2006, the Saltillo stand is better.

Black grama:

'Sonora' is much more rhizomatous than 'Nogal' in this planting. 'Sonora' also seems to continue to grow throughout the summer season, where 'Nogal' appears to shut down during the hottest months. Seed from 'Sonora' mature earlier, perhaps before the monsoon rains.

Black Grama Cultivars

Sand lovegrass:

'Mason' is much more adapted to conditions in this trial than 'Bend'. In 2006 both stands are poor. In 20007 both cultivars only have a few surviving plants.

Although this trial was planted as a demonstration it is providing valuable information on the adaptability of various plant materials releases being planted in southern Arizona. It has also proven to be invaluable when discussing species variability with students, field office personnel and other PMC visitors.

Tucson Plant Materials Center Native Grass Demonstration

Audubon Ranch Fields at the Tucson PMC

STUDY NUMBER: AZPMC-T-06-08-CR

The Audubon Society's Appleton-Whittle Research Ranch outside Elgin, AZ, are committed to combating Lehmann and Boer lovegrasses (*Eragrostis lehmanniana and E. curvula*). Both exotic species have increased following a catastrophic fire in 2002. In the future, the Ranch may hold some of the last vestiges of native grasslands in southern Arizona.

The Ranch wanted to look at simplified land management uses following the good monsoon rains in 2005 that produced an above average native seed crop. We decided to do a mixed-species harvest, skip the seed processing step, and spread the seed the way it's done in nature. The Woodward flail-vac was used for harvesting to do as little damage as possible to the harvest site. The seed harvest included blue grama, black grama, hairy grama, sideoats grama, sprucetop grama, plains lovegrass, cane beardgrass, various Forbs and sub-shrubs.

The 150+ lbs of seed will be available for reseeding multiple test plots at the Ranch, as well as a mixed species border here at the PMC.

In 2006, seed from the Ranch was used to establish a species rich field. Production of haybales from this field will be used in projects using mulch as a method of propagule distribution. In 2006 this 1 acre field produced 48 bales weighing approximately 55 lbs. These bales will be used in 2007 projects on the ranch as well as on various PMC field plantings.

In 2007 this field was maintained. Production was hindered by the lack of available irrigation (well repair). No harvest was made from this field in 2007.

Mary harvests seed from native stands at the Audubon Research ranch in 2005 (above); Tyler established two borders at the PMC in

Introduction of Native Species Diversity into Exotic Lovegrass infestations

STUDY NUMBER: AZPMC-T-0607-IN

STUDY NUMBER: AZPMC-T-0606-IN

Introduction

Much of Southern Arizona's biologically diverse grasslands are increasingly threatened by the invasion of exotic lovegrasses, but little is known about their management or control, or the economic return from such efforts. In fall 2005, the Tucson PMC harvested seed from the abundant grasslands of the Appleton-Whittell Research Ranch of the Audubon Society in Elgin, Arizona, to answer some of these questions. Using seed from that harvest, a replicated study was initiated in 2006 by the PMC and the Research Ranch near the harvest site to investigate the potential for patch establishment of native species into an invasive-dominated site of Boer lovegrass (*Eragrostis curvula*). Boer lovegrass, and to an even greater extent, lehmann lovegrass (*E. lehmanianna*), have been present in relatively small quantities on the Ranch for years, but have become dominant over much of the range following the catastrophic Ryan fire in 2002.

Methods

Seed harvested from the ranch was minimally processed (once through the hammermill) for use in this project. Multiple species of grasses and forb seed, including *Eragrostis intermedia, Bouteloua gracilis, B. hirsuta, B. eriopoda, B. curtipendula, B. chondrosioides, Bothriochloa barbinodis, Digitaria californica, Lycurus phleoides, Leptochloa dubia, Aristida spp., Sida filicaulis, Ipomoea coccinea, Viguiera annua, Convolvulus equitans* were identified in the seed mix. The harvest site was selected based on its low density of exotic grasses. Because the few Lehmann lovegrass patches encountered at the site were avoided while harvesting, very little Lehmann lovegrass should have entered into the seed mix.

The purpose of this study was to investigate the potential for the removal of patches of Boer lovegrass within a large infestation and to increase native diversity within those patches with the use of several cultural practices:

Mowing- with diesel tractor and rotary mower
Broad-spectrum herbicide- Roundup Ultra 5% rate and blue dye
Growth suppressant- Embark 2-S at 4 pints/ac and blue dye
Seeding- Native seed planted with FLXII Truax No-Till Grass Drill (1" depth)

Four replications of the following treatments were equal in size and arranged randomly in replicated complete block grid pattern (Figure 1):

- mow & herbicide & seed
- mow & growth suppressant & seed
- mow & seed
- seed only
- control

All 20 plots were 50 ft by 8 ft, with a 5 ft buffer around each plot to prevent overlap of treatments. The equipment was passed through each block to ensure uniformity of the treatments. Plots were delineated by colored rebar stakes.

The plots were set up and treated during the month of July. Four of the five treatments (16 plots) were mowed. Seven days later, four of the mowed plots were sprayed with herbicide, and another four of those plots were sprayed with a growth suppressant hormone. Three days following the spraying, four of the five treatments (all but the control plots) were seeded with a drill. Approximately 40 seed/sq ft were seeded in the plots, double the recommended range seeding rate to increase the opportunity of germination. Approximately 14.46 lb/ac was used in each of the drill's boxes (fluffy seed and small seed) for all plots combined. The growth suppressant hormone treatment was rendered ineffective due to multiple rainfall events following application, and this treatment was dropped from the study.

Plot pattern following mowing and spraying

Seedlings began to emerge following the summer rains July through September. On October 19 the four active treatments in the Boer treatments were evaluated. Data were collected from within a 1 m x 0.5 m frame placed randomly twice in each plot. Seedlings of perennial species and mature perennial species were identified in each frame. The four treatments were evaluated according to the following variables:

- Mean frequency of native grass seedlings
- Mean frequency of exotic grass seedlings
- Mean frequency of native forb seedlings

- Mean frequency of mature native grasses
- Mean frequency of mature exotic grasses
- Mean frequency of mature native forbs

- Mean species composition of seedlings
- Mean species composition of mature plants

- Vegetation cover in frame (Daubbenmeier cover class score)

Plants that were established in the plots previous to treatment (mature native grasses, forbs and exotic grasses) were recorded in each frame. Seedlings of native grasses, forbs and exotic grasses were identified using a seedling identification guide and recorded in each frame. Species composition was listed for mature plants and seedlings; these totals number

represent the overall species composition variable. Species composition for native grasses, native forbs and exotic grasses were also recorded. Cover was estimated in each frame using Daubbenmeier scores.

Results

Following treatment the first year

The plots sprayed with herbicide had significantly lower cover scores ($p=0.0053$, Table 1) and significantly lower species composition of mature plants ($p<0.0005$, Tables 5, 7, 9 and 11) than the plots that were not sprayed. However, there was no difference in mean frequency of mature native grasses ($p=0.147$), mature exotic grasses ($p=0.203$) or mature forbs ($p=0.75$) between treatments.

Jennifer Arnold (NRCS Tucson Field Office), Linda Kennedy (Research Ranch) and Leslie Wood (PMC) examine seedlings in the frame.

Table 1. Cover and Mature Plant Composition following Treatment

Treatment	N	Vegetation Cover (%)	Species composition of mature plants (#)
Mow & Herbicide & Seed	8	11.63 b	0.25 b
Mow & Seed	8	45.25 a	6.28 a
Seed only	8	42.50 a	4.25 a
Control	8	53.13 a	5.38 a

Values followed by different letters are significantly different ($\alpha=0.05$)
Randomized complete block AOV and LSD All-Pairwise Tukey Test were conducted.

In terms of plant establishment, a significantly greater number of native grass seedlings germinated in the sprayed plots than the control plots ($p=0.023$, Table 2). A greater number of exotic grass seedlings germinated in the sprayed plots than the mowed plots, although this difference was not statistically significant ($p=0.084$). Of the 32 total plots examined, 3 plots had Boer lovegrass seedlings, and 8 plots had Lehmann lovegrass seedlings. Three of the eight plots containing Lehmann lovegrass seedlings were in the plots sprayed with herbicide. Slightly greater numbers of forb seedlings came up in sprayed plots than the control plots and the seeded only plots ($p=0.183$).

Seedlings emerging from drill rows in a plot mowed, sprayed and seeded.

Species composition of seedlings was significantly greater in the sprayed plots than the other treatments (p=0.0003, Table 2 and Tables 5, 7, 9 and 11).

Table 2. Frequency and Composition of Seedlings Following Treatment

Treatment	N	Native grass seedlings (#)	Exotic grass seedlings (#)	Species composition of seedlings (#)
Mow & Herbicide & Seed	8	70.72 a	18.28	8.13 a
Mow & Seed	8	43.00 ab	0.75	4.35 b
Seed only	8	45.50 ab	5.38	2.75 b
Control	8	11.00 ab	5.88	2.87 b

Values followed by different letters are significantly different (α=0.05)
Randomized complete block AOV and LSD All-Pairwise Tukey Test were conducted.

Plant establishment and maintenance in the second year

The results in 2007, the year following the treatment year, is closely linked to the plants that established in the planting the previous year. In contrast to 2006, few seedlings germinated in any of the plots in 2007; on average, zero to three were observed in each plot. No significant differences were observed between treatments in numbers of native grass seedlings (p=0.222), exotic grass seedlings (p=0.351), or native forb seedlings (p=0.318), although for all three types slightly more seedlings germinated in the sprayed plots. Of the few seedlings that did germinate, no difference (p=0.7389) and overall low species composition was observed in all treatments - the lowest, the control, had a mean of 1 species of seedling per plot, the greatest, the sprayed plots, had a mean 1.8 species of seedling per plot (Tables 6, 8, 10 and 12).

Greater numbers of mature plants (those in the plot prior to treatment as well as those established the previous year) were observed in the plots where vegetation was removed the previous year. Although the difference was not significant, a greater number of mature native grasses were found in the sprayed plots and the mowed plots than the plots were no vegetation was removed (p=0.184, Table 3). More mature exotic grasses were also observed in the sprayed plots, although this difference was not significant (p=0.341). A greater number of mature forbs were also recorded in the sprayed plots than the other treatments (p=0.054). Despite the greater numbers of mature plants in the sprayed plots, the cover score was significantly lower in those plots than the sprayed plots (p=0.029).

Table 3. Frequency of Mature Plants and Vegetation Cover

Treatment	N	Native grasses (#)	Exotic grasses (#)	Forbs (#)	Veg. Cover (%)
Mow & Herbicide & Seed	8	16.8	14.38	7.9	29.75 b
Mow & Seed	8	16.1	4.75	4.3	59.38 a
Seed only	8	9.6	4.63	2.0	53.50 a
Control	8	3.3	5.63	2.5	63.75 a

Values followed by different letters are significantly different (α=0.05)
Randomized complete block AOV and LSD All-Pairwise Tukey Test were conducted.

There was a significantly greater overall species composition of mature plants in the sprayed plots than the control plots (p=0.020, Table 4) in this second year following treatment. A

significantly greater diversity of mature native grasses were recorded in the sprayed plots than the control plots (p=0.006), and although not significant, a greater variety of mature native forbs were found in the sprayed plots than the controlled or seeded only plots (p=0.099). No significant differences in species composition of mature exotic grasses were found between treatments (p=0.502); on average, most plots had at least one of the two *Eragrostis* species (Tables 6, 8, 10 and 12).

Table 4. Species Composition of Mature Plants

Treatment	N	Native grasses (#)	Native forbs (#)	Overall Composition (#)
Mow & Herbicide & Seed	8	5.0 a	3.4	9.1 a
Mow & Seed	8	3.1 ab	2.6	6.9 ab
Seed only	8	2.4 ab	1.3	4.8 ab
Control	8	1.3 b	1.5	4.0 b

Values followed by different letters are significantly different (α=0.05)
Randomized complete block AOV and LSD All-Pairwise Tukey Test were conducted.

Discussion

The Boer lovegrass study demonstrated several interesting findings over the two years of data collection. The fact that numbers of plants prior to treatment in 2006 – both native and exotic— did not differ between treatments suggests that the plots had low vegetative density initially. Hence, even a relatively sparse lovegrass infestation can have a large effect on the potential for establishing native species. The preliminary year of the study also demonstrated that no two weeds are alike. Although the dominant species at the site, and presumably in the seed bank, was Boer lovegrass, Lehmann lovegrass germinated even more readily. Both species are cause of concern, but Lehmann lovegrass appears to be the more aggressive of the two.

In the treatment year of 2006, plots that were mowed, sprayed and seeded had the least vegetation cover, experienced the greatest grass seedling increase, and had the highest species composition of seedlings. These results appear to point in favor of native plant establishment. However, use of herbicide followed by the drill's minor disturbance to the soil surface also provided optimum conditions for germination of exotic seed present in the soil. Due to the fact that care was taken to avoid the patches of invasive species in the seed harvest, the exotic seedlings had to have emerged from the seed bank, not from the seed mix. Spraying with herbicide removed preexisting plants at the site, providing space and resources for the germination of a greater number and diversity of seedlings- both native and exotic. This fact may be a cause of concern because any effort to establish native species in an invasive-dominated site will simultaneously increase the invasive species in the seed bank. Restoration efforts to increase native species diversity using chemical control and seeding will require follow-up of weed control.

On the other hand, the results of mowing in the treatment year may potentially provide options for the restorationist. Fewer exotic seedlings established in the plots that were mowed and seeded than those that were mowed, sprayed and seeded. Cut biomass left on the ground in the mowing process shades the soil surface. This shading effect may prevent the establishment of exotic grass seedlings, which require light to germinate. By increasing the

open canopy through herbicide application, the greatest number of exotic seedlings germinated, and by increasing shade by mowing, the fewest number of exotic seedlings established. Providing shade through mulch may decrease the prevalence of exotic seedling establishment, and hence may be an additional tool for increasing native diversity with fewer exotics.

The year following the treatment year, 2007, further demonstrates that removal of exotic vegetation allows for establishment of native diversity. The seedlings from the treatment year of 2006 persisted into the following year as mature plants. This was demonstrated by the fact that the greatest number of mature plants was recorded in the sprayed plots and mowed plots in 2007, not the seeded only and control plots, where plants were already growing. The preexisting plants in those plots were larger, however, which explains the greater cover value in the frame. In addition, few seedlings established in the second year, as little open ground was available for germination.

Not only did more mature native grasses and forbs persisted into the second year in the sprayed plots, but mature exotic grasses did as well, perhaps making questionable the issue of success in a restoration effort such as this one. However, the fact that species composition of mature plants was greatest in the sprayed plots – particularly for native grasses and forbs – gives weight to the use of chemical control in efforts of increasing patch establishment of native diversity into an invasive-dominated site.

Conclusion

The establishment of native species in stands of exotic grasses may be possible through the removal of existing vegetation. However, due to the fact that patch establishment of native vegetation through herbicide application simultaneously establishes the exotic vegetation in the area, additional long-term information on species composition, and requirements of follow-up weed control efforts, are required to determine feasibility of these types of restoration efforts. In addition, more comprehensive studies are needed to establish a methodology for vegetation removal and seeding into exotic-dominated sites. For instance, studies involving additional weed treatment methods and those that control for each additional treatment or combination of treatments will provide a clearer explanation for the processes taking place. Finally, studies involving the use of hay bales harboring native seed will provide information on the shading effect, and the potential for preventing germination of exotic seed in the seed bank while providing resources for the germination of native plants.

Table 5. Species Composition in *Mow + Herbicide + Seed* Treatment, 2006 (Year 1)

Block	Frame	Species- seedlings	Species- mature plants
A	1	*Grasses*- ERLE[1],ERIN,BOGR,LEDU,ARTE,LYPH *Forbs*- Croton, Sida NM, Dychariste, Evolvulus, Chaetopappa, Portulaca suffrutescens, Falls witchgrass (Digitaria cognata)	None
A	2	*Grasses*- ERLE[1],BOCU,ERIN,ARTE,DICA,BOHI	None
B	1	*Grasses*- DICA,ARHA,ERIN,BOGR,LEDU *Forbs*- Dychariste, Sida, Cudweed, daisy	None
B	2	*Grasses*- ERCU[1],ERIN,ARTE,BOCU *Forbs*- Dychoriste,Daisy, Cercium (thistle)	None
C	1	*Grasses*- ERIN,BOCU,LEDU,ARTE,DICA	*Grasses*- ERCU[1] *Forbs*- Dychariste gnaphalium
C	2	*Grasses*- ERLE[1],ERIN,LEDU,DICA,BOCH *Forbs*- Sida, Dychoriste, Evolvulus, bundleflower	None
D	1	*Grasses*- DICA,LEDU,BOGR *Forbs*- Cudweed, bundle flower, Mtn. caliandra, ragweed,evolvulus, dychoriste	None
D	2	*Grasses*- DICA,ARTE,ERIN,BOGR,LYPH *Forbs*- Daisy,Cudweed,Desert marigold, Conyzia	None

[1]Exotic grasses consisted of ERLE (Lehmann lovegrass) and ERCU (Boer lovegrass)

Native grass species consisted of ERIN (Plains lovegrass), LEDU (Green sprangletop), ARTE (Purple threeawn), ARHA (Spidergrass), LYPH (Common wolftail), DICA (Arizona cottontop), HIBE (Curly mesquite), BOBA (Cane beardgrass), BOGR (Blue grama), BOCU (Sideoats grama), BOCH (Sprucetop grama), BOER (Black grama).

Table 6. Species Composition in *Mow + Herbicide + Seed* Treatment, 2007 (Year 2)

Block	Frame	Species- seedlings	Species- mature plants
A	1	*Grasses*- ERLE[1], BOGR, ERIN *Forbs*- none	*Grasses*- ERCU[1], ERLE[1], DICO, LYPH, BOGR, BOCU, ERIN, DICA, ARDI *Forbs*- Evolvulus, Ragweed
A	2	*Grasses*- ERLE[1], BOGR Forbs- Dychoriste	*Grasses*- ERLE[1], BOGR, BOCU, ERIN, ARDI Forbs- Evolvulus
B	1	*Grasses*- ERLE[1], BOGR, BOCU, ERIN, ARDI *Forbs*- Evolvulus	*Grasses*- ERLE[1], BOGR, DICA, ARTE, LEDU, ERIN, BOCU, BOHI *Forbs*- Cudweed, Sida Abutifdia, Ragweed, Erigeron, Dischoriste, Evolvulus
B	2	None	*Grasses*- BOGR, DICA, ARTE, BOCU *Forbs*- Erigeron, Conyzia (SP)
C	1	None	*Grasses*- ERLE[1], BOGR, DICA, ERIN, ARTE, BOHI *Forbs*- Cudweed, Sida, Dischoriste
C	2	*Grasses*- ERLE[1]	*Grasses*- ERLE[1], Grama sp Forbs- Evolvulus, Bundleflower
D	1	*Grasses*- ERIN	*Grasses*- DICA, BOCU, BOGR, BOBA, ARTE *Forbs*- Conyzia, Ragweed, Chaetopappa, Erigeron, Cudweed, Calliandra humulis
D	2	*Forbs*- Cudweed	*Grasses*- ARTE, DICA, LYPH, ARDI, BOCU, BOGR, HIBE *Forbs*- Cudweed, Conyzia, Ragweed, Chaetopappa, Erigeron

[1]Exotic grasses consisted of ERLE (Lehmann lovegrass) and ERCU (Boer lovegrass)

Native grass species consisted of ERIN (Plains lovegrass), LEDU (Green sprangletop), ARTE (Purple threeawn), ARHA (Spidergrass), LYPH (Common wolftail), DICA (Arizona cottontop), HIBE (Curly mesquite), BOBA (Cane beardgrass), BOGR (Blue grama), BOCU (Sideoats grama), BOCH (Sprucetop grama), BOER (Black grama).

Table 7. Species Composition in *Mow + Seed* Treatment in 2006 (Year 1)

Block	Frame	Species- seedlings	Species- mature plants
A	1	*Grasses*- ARTE *Forbs*- Sida, Dyschariste	*Grasses*- ERCU[1],BOCU *Forbs*- Hierba de pasmo, convolvulus, sida, evolvulus, ragweed, chaetopappa, mimosa
A	2	*Grasses*- ERLE[1],BOGR,ATRE,ERIN *Forbs*- Ragweed, Evolvulus, Dychoriste	*Grasses*- ERLE[1],HIBE,BOCU,BOGR,ERIN,ARTE, DICA,BOHI
B	1	*Grasses*- BOGR	*Grasses*- ERCU[1],BOGR *Forbs*- Dychoriste, Ragweed
B	2	*Grasses*- BOCU,ERIN, *Forbs*- Dychoriste,Mtn. Caliandra	*Grasses*- ERCU[1],BOGR *Forbs*- Evolvulus,Prostrate sida,Upright sida
C	1	No data	No data
C	2	*Grasses*- BOGR,ATRE,DICA,LEDU *Forbs*- Dychoriste, Portulaca, Daisy, Evolvulus,Hybanthus	*Grasses*- BOGR *Forbs*- Sida, Evolvulus, bundle flower, flame flower
D	1	*Forbs*- Ragweed, Dychoriste	*Grasses*- ERCU[1],BOER *Forbs*- Evolvulus, Dychoriste
D	2	*Forbs*- Dalea, bundleflower, Dychoriste	*Grasses*- ERCU[1],BOBA,BOCU,BOCH,ERIN *Forbs*- Dychoriste, Bundle flower, Upright sida, Portulaca suffrutescens

[1]Exotic grasses consisted of ERLE (Lehmann lovegrass) and ERCU (Boer lovegrass)

Native grass species consisted of ERIN (Plains lovegrass), LEDU (Green sprangletop), ARTE (Purple threeawn), ARHA (Spidergrass), LYPH (Common wolftail), DICA (Arizona cottontop), HIBE (Curly mesquite), BOBA (Cane beardgrass), BOGR (Blue grama), BOCU (Sideoats grama), BOCH (Sprucetop grama), BOER (Black grama).

Table 8. Species Composition in *Mow + Seed* Treatment in 2007 (Year 2)

Block	Frame	Species- seedlings	Species- mature plants
A	1	*Grasses*- BOGR, Aristida spp	*Grasses*- ERCU[1], BOGR, BOCU, ERIN *Forbs*- Evolvulus, Chaetopappa, Hierba de pasma, Ragweed, Talinum, Mimosa
A	2	*Grasses*- ERLE[1], BOGR, Aristida spp *Forbs*- Dyschoriste	*Grasses*- ERLE[1],ERCU[1], BOGR, ERIN, ARDI, BOCU, HIBE *Forbs*- Ragweed, Evolvulus, Talinum, Desmanthus
B	1	*Grasses*- Grama sp	*Grasses*- ERCU[1], BOGR *Forbs*- Sida abutifolia
B	2	*Grasses*- ERLE[1]	*Grasses*- ERLE[1], ERCU[1], BOGR *Forbs*- Portulaca suffrutescens
C	1	*Forbs*- Erigeron (daisy)	*Grasses*- ERLE[1], BOGR *Forbs*- Ragweed
C	2	*Grasses*- BOGR, DICA, BOHI	*Grasses*- BOER, BOCU, DICA, ERIN, LEDU, LYPH, ARTE, BOHI *Forbs*- Evolvulus, Talinum, Ragweed, Desmanthus, Erigeron (daisy)
D	1	None	*Grasses*- HIBE, BOGR, LYPH *Forbs*- Bundleflower, Ragweed
D	2	None	*Grasses*- ERCU[1], ERLE[1], BOBA, ERIN, BOCU *Forbs*- Hierba de Pasmo

[1]Exotic grasses consisted of ERLE (Lehmann lovegrass) and ERCU (Boer lovegrass)

Native grass species consisted of ERIN (Plains lovegrass), LEDU (Green sprangletop), ARTE (Purple threeawn), ARHA (Spidergrass), LYPH (Common wolftail), DICA (Arizona cottontop), HIBE (Curly mesquite), BOBA (Cane beardgrass), BOGR (Blue grama), BOCU (Sideoats grama), BOCH (Sprucetop grama), BOER (Black grama).

Table 9. Species Composition in *Seed Only* Treatment in 2006 (Year 1)

Block	Frame	Species- seedlings	Species- mature plants
A	1	*Grasses*- ERIN,ARTE,BOGR,DICA	*Grasses*- ERCU[1],BOGR
A	2	*Grasses*- ERIN,ARTE,BOGR	*Grasses*- ERCU[1],BOCU,BOGR *Forbs*- Dychoriste, Chaetopappa
B	1	*Forbs*- Dychoriste	*Grasses*- ERCU[1],ERLE[1],ERIN,BOCU,BOGR *Forbs*- Dychoriste, Evolvulus, bundleflower
B	2	*Grasses*- ERLE[1],ARTE	*Grasses*- ERLE[1], Panic grass *Forbs*- Evolvulus, Prostrate sida, bundle flower, Dalea
C	1	*Grasses*- ERLE[1],BOGR,LEDU,ERIN *Forbs*- Portulaca, Dychariste, Calliandra hymulus	*Grasses*- ERCU[1],BOGR *Forbs*- Dychariste, Evolvulus, Poinsetta radiens
C	2	*Grasses*- BOCU,BOGR *Forbs*- Sida, Portulaca, Dychoriste	*Grasses*- BOGR,BOCU *Forbs*- Sida
D	1	*Grasses*- BOGR	*Grasses*- ERCU[1]
D	2	*Grasses*- LYPH *Forbs*- Dychoriste	*Grasses*- ERCU[1],BOBA *Forbs*- Evolvulus, Chaetopappa

[1]Exotic grasses consisted of ERLE (Lehmann lovegrass) and ERCU (Boer lovegrass)

Native grass species consisted of ERIN (Plains lovegrass), LEDU (Green sprangletop), ARTE (Purple threeawn), ARHA (Spidergrass), LYPH (Common wolftail), DICA (Arizona cottontop), HIBE (Curly mesquite), BOBA (Cane beardgrass), BOGR (Blue grama), BOCU (Sideoats grama), BOCH (Sprucetop grama), BOER (Black grama).

Table 10. Species Composition in *Seed Only* Treatment in 2007 (Year 2)

Block	Frame	Species- seedlings	Species- mature plants
A	1	*Grasses*- BOGR, Aristida sp *Forbs*- Talinum	*Grasses*- ERCU[1], ARTE, DICA, BOGR
A	2	*Grasses*- ERCU[1]	*Grasses*- ERCU[1], BOGR, DICA *Forbs*- Chaetopappa, Dyschoriste
B	1	None	*Grasses*- ERLE[1], ERCU[1], BOCU *Forbs*- Dischoriste, Bundleflower, Evolvulus, Sida decumbens
B	2	*Grasses*- ERLE[1], Grama sp., ARTE	*Grasses*- Halls panic, DICO, BOHI, BOGR *Forbs*- Sida abutifolia
C	1	*Grasses*- BOGR, BOCU, Aristida sp	*Grasses*- ERLE[1], ERCU[1], BOCU, ERIN, BOGR, ARTE, LEDU *Forbs*- Dischoriste, Sida
C	2	*Grasses*- BOGR	*Grasses*- ERCU[1], BOGR, BOCU, DICA *Forbs*- Sida
D	1	None	*Grasses*- ERCU[1]
D	2	None	*Grasses*- ERCU[1], BOBA

[1]Exotic grasses consisted of ERLE (Lehmann lovegrass) and ERCU (Boer lovegrass)

Native grass species consisted of ERIN (Plains lovegrass), LEDU (Green sprangletop), ARTE (Purple threeawn), ARHA (Spidergrass), LYPH (Common wolftail), DICA (Arizona cottontop), HIBE (Curly mesquite), BOBA (Cane beardgrass), BOGR (Blue grama), BOCU (Sideoats grama), BOCH (Sprucetop grama), BOER (Black grama).

Table 11. Species Composition in *Control* in 2006 (Year 1)

Block	Frame	Species- seedlings	Species- mature plants
A	1	*Grasses*- BOGR	*Grasses*- ERCU[1],BOCU,BOGR
A	2	None	*Grasses*- ERCU[1],BOGR *Forbs*- Day Flower, Bundle flower, chaetopappa
B	1	*Forbs*- Cudweed, prostrate sida	*Grasses*- ERCU[1],BOCU *Forbs*- Daisy, Evolvulus, bundleflower, Prostrate sida
B	2	*Grasses*- ERLE[1] *Forbs*- Bundle flower, Mtn. Calliandra	*Grasses*- ERCU[1],ERLE[1],ERIN *Forbs*- Evolvulus, prostrate sida
C	1	*Grasses*- ERLE[1],ERCU[1],HIBE *Forbs*-Dychariste, Bundleflower, Sida NM	*Grasses*- ERCU[1],BOCU,HIBE,BOCH *Forbs*- Portulaca, Bundleflower, Sida
C	2	*Grasses*- ERCU[1], Unk. grama species *Forbs*- Dychoriste, Sida NM	*Grasses*- ERCU[1],BOGR *Forbs*- Unknown forb
D	1	*Forbs*- Dychoriste	*Grasses*- ERCU[1],BOGR,HIBE,BOCH,LYPH *Forbs*- Chaetopappa, Red maids, Bundleflower
D	2	*Forbs*- Portulaca suffrutescens, Dychoriste, Mtn. Caliandra, falls witchgrass, hybanthus	*Grasses*- ERCU[1],BOGR,BOER *Forbs*- Ragweed, Evolvulus

[1]Exotic grasses consisted of ERLE (Lehmann lovegrass) and ERCU (Boer lovegrass)

Native grass species consisted of ERIN (Plains lovegrass), LEDU (Green sprangletop), ARTE (Purple threeawn), ARHA (Spidergrass), LYPH (Common wolftail), DICA (Arizona cottontop), HIBE (Curly mesquite), BOBA (Cane beardgrass), BOGR (Blue grama), BOCU (Sideoats grama), BOCH (Sprucetop grama), BOER (Black grama).

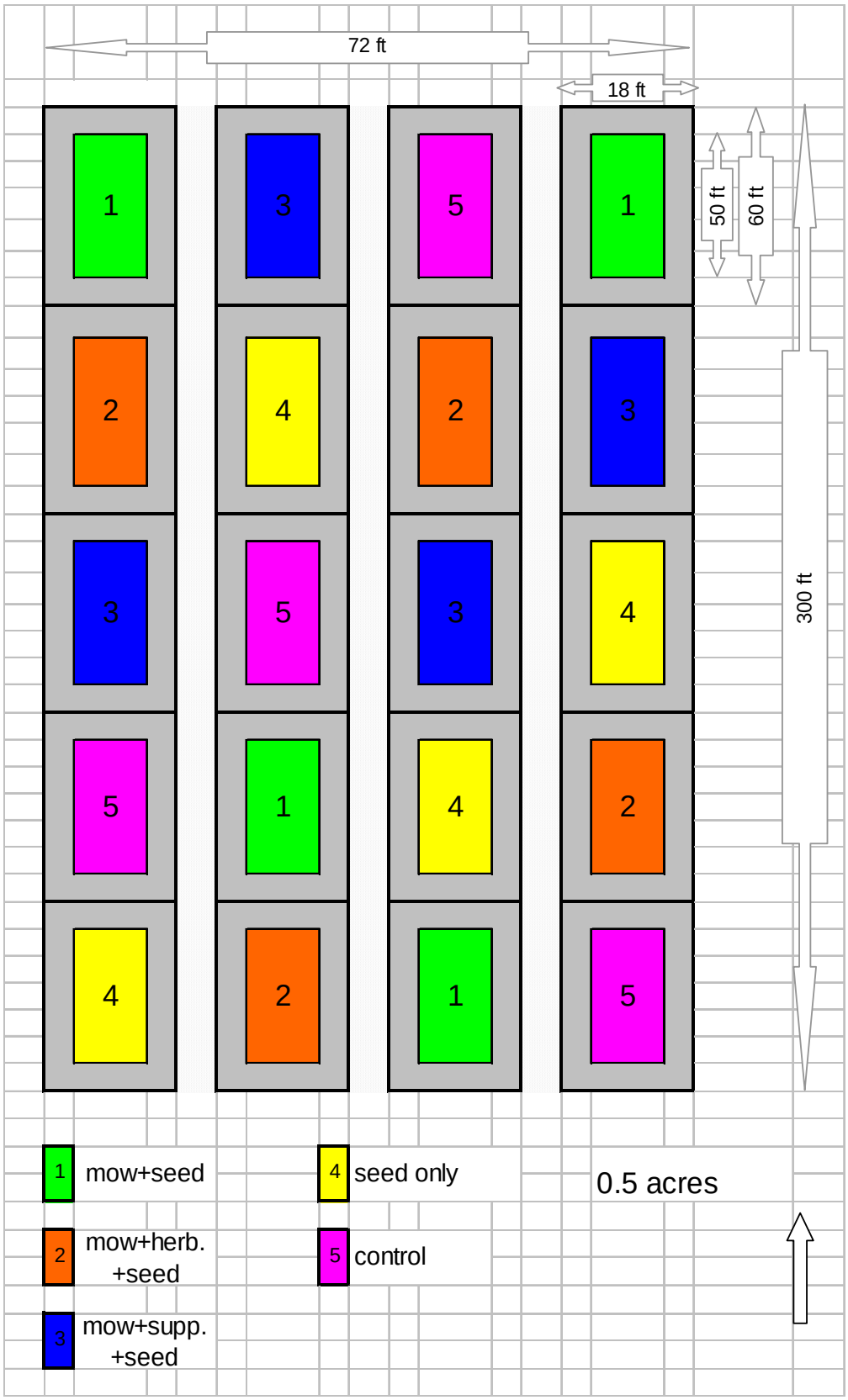
Table 12. Species Composition in *Control* in 2006 (Year 2)

Block	Frame	Species- seedlings	Species- mature plants
A	1	*Grasses*- BOGR, BOCU	*Grasses*- ERCU[1],BOCU,BOGR *Forbs*- Solanum (silverleaf nightshade)
A	2	None	*Grasses*- ERCU[1],BOGR *Forbs*- Talinum
B	1	*Grasses* - LYPH *Forbs*- Erigeron	*Grasses*- ERCU[1],BOCU *Forbs*- Sida abutifolia
B	2	None	*Grasses*- ERCU[1],ERLE[1],ERIN *Forbs*- Evolvulus, Sida abutifolia
C	1	None	*Grasses*- ERCU[1],ERLE[1],BOCU *Forbs*- Bundleflower (desmanthes cooleyii), Sida
C	2	None	*Grasses*- ERCU[1]
D	1	None	*Grasses*- ERCU[1],BOER
D	2	None	*Grasses*- ERCU[1],BOGR,BOER, DICO Forbs- Ambrosia, Bundleflower, Dischoriste, Evolvulus

[1]Exotic grasses consisted of ERLE (Lehmann lovegrass) and ERCU (Boer lovegrass)

Native grass species consisted of ERIN (Plains lovegrass), LEDU (Green sprangletop), ARTE (Purple threeawn), ARHA (Spidergrass), LYPH (Common wolftail), DICA (Arizona cottontop), HIBE (Curly mesquite), BOBA (Cane beardgrass), BOGR (Blue grama), BOCU (Sideoats grama), BOCH (Sprucetop grama), BOER (Black grama).

Figure 1. Plot Plan of Treatments



Year Three of Mojave Desert Project with BLM and High Desert RC&D

STUDY NUMBER: AZPMC-P-0401-CR

STUDY NUMBER: AZPMC-T-0403-CR

STUDY NUMBER: AZPMC-P-0404-CR

STUDY NUMBER: AZPMC-S-0601-CP

STUDY NUMBER: AZPMC-S-0701-CP

Introduction

Year 2007 was the third and final year of a unique interagency collaborative project with a double objective: to develop two species releases of regional adaptation to southern Nevada, and to establish fields of these species with local commercial growers. This year the Tucson Plant Materials Center (PMC), Bureau of Land Management-Las Vegas Field Office (BLM) and High Desert Resource Conservation & Development (RC&D) released a second species and put it into commercial production.

Scratchgrass field at Tucson PMC in July 2007

Scratchgrass (or Alkali muhly) (*Muhlenbergia asperifolia)* is the second riparian species released for this project as a selected class of certified seed. Named Moapa germplasm Scratchgrass after one of the collection sites used to develop the release, this species has great potential for conservation use, growing by stolons, rhizomes and seed.

This year at the Tucson PMC, both Moapa Scratchgrass and the previous year's release, Vegas Alkali sacaton (*Sporobolus airoides*), were harvested for seed. Increase fields of Moapa germplasm Scratchgrass were planted in the spring following the commercial plantings in Nevada. Alkali sacaton increase fields planted the previous year were harvested for the first time.

Scratchgrass plugs growing in the PMC greenhouse

Moapa germplasm Scratchgrass: a second species for commercial seed production

In mid-October 2006 Moapa Scratchgrass was harvested at the Tucson PMC for the first time. A total of 4.5 lb of seed was harvested from the 0.25 ac. Following the seed harvest, five 40-lb haybales were also cut from the field. Seed were conditioned with the Hammermill and Clipper, and tests determined the germination rate to be 44.5%.

In April 2007, plugs were sewn with seed from the October harvest. When only half of the plugs sprouted seedlings, an inspection under the microscope determined that one of the bags was virtually empty of seed (full of chafe). The seed conditioning process not only separates stems and other inert material from the

seed, but also separates seed by size and weight. In order to include all of the genetic material from the seed harvest into the plugs going to Nevada, both sizes of seed – the large and the small (mostly chafe) –had been used. Plugs were reseeded with the viable seed and with an increase of fertilizer the new plugs were ready for planting in only 4 weeks- just in time for the trip to Nevada.

Teri of High Desert RC&D and Mary and Ramona of the Tucson PMC finish weeding Moapa School fields (May 2007)

The week of May 21-25 plantings of Scratchgrass was scheduled at the two farms in Nevada. This year, the second species was planted into commercial production to complete the goal of the project, in addition to two other motivations at issue: large public events planned at both sites, and the opportunity to inspect the previous year's plantings.

A total of 13,500 plugs were transported to Nevada, with the intention of planting 1.5 ac at Moapa School in Overton and 0.5 ac at Sunrise Acres in Pahrump. Due to knowledge about the weedy conditions at Moapa School and the previous year's difficulty planting in Pahrump, the Tucson PMC's 4 person crew split their forces between the two sites in preparation for the plantings. One team drove directly to Pahrump to ensure adequate preparation of the fields, and within a few hours the fields were ripped deeply enough for the planting the following day. The second team traveled to Moapa, where the second planting was to take place. They had made previous arrangements to meet with Teri Knight, the RC&D coordinator, and local supporters of the project, Elise McAllister and Chris Green, to hoe the fields of the previous years' planting of Vegas Alkali sacaton.

The public event in Pahrump hosted a crowd including Senator Reid's aide, who presented an award to the farmer

After a day of hoeing, several of the Alkali sacaton rows were clean of weeds, and deemed presentable for the public event. It was clear that the fields at Moapa School were not being maintained. The day's work also proved that consistent efforts of manual weed control could prove successful if employed. It was decided only 0.5 ac (rather than 1.5 ac) of Moapa Scratchgrass would be planted, as it would be all the school could maintain weed-free. The maintenance of these fields would be under close scrutiny for the next several months.

Good showings of the public and involved agencies arrived for the plantings at both locations. A highlight at each event was the presence of an assistant to Senator Harry Reid, who presented awards of excellence to each of the farmers, emphasizing the importance of this kind of work for environmental conservation in Nevada. The plantings at both locations went smoothly and efficiently, with enthusiasm and overall success.

2007: A dry year at the PMC

Upon return to Arizona following the Nevada plantings, 0.8 ac of increase fields of Moapa germplasm Scratchgrass was planted. The plugs established and for three weeks began to extend across the field until early July, when the PMC well was shut off for replacement. It was not until October that the well was flowing water again, and in the meantime it was questionable whether the young Scratchgrass plants would survive the long drought. As it turned out, the few rains of summer provided the moisture the plants required for survival. The Scratchgrass increase fields did not thrive that year, but gave testament to the durability of native plants, particularly this planting, in that they did not succumb to drought conditions.

Jace, Heather and Leslie of the Tucson PMC plant a field of Scratchgrass (June 2007)

The 0.65 acres of increase fields of Vegas Alkali sacaton planted in October 2006 grew consistently during spring 2007, producing 49 lb of seed in June. They too suffered during the summer, however. The fields were mowed and baled following the seed harvest to decrease the impact of the drought, producing 50 hay bales. Immediately following the first irrigation in October they greened up and began to put up seed heads, although due to the late timing in the season, this seed was not harvested.

Increase fields of Alkali sacaton at Tucson PMC in June 2007

In contrast, the composite field (F1) of Alkali sacaton planted in 2005 seemed to not miss a beat. Despite the drought, the fact that the plants had been established for 2 years permitted a seed harvest of this 0.25 ac field in September (4.5 lb), before the well was even completed.

Vegas germplasm Alkali sacaton: a year in production

Although the purpose of the 2007 plantings in Nevada was the establishment of the second species, Scratchgrass, the focus of attention was on Alkali sacaton, because these fields represent the success of the project thus far. To quote the previous year's annual report,

> This is a pilot project, so the process of establishing first-time native seed growers through a collaborative project between two federal agencies and the local RC&D is completely experimental.

This issue of success continues to be in question, but after a year in production, the Alkali sacaton fields give a certain amount of insight. The continued apparent indifference by Moapa School ultimately caused their contract to be cancelled in November.

Certainly not everyone involved was indifferent. During the year following the 2006 plantings in Nevada, the High Desert RC&D coordinator Teri Knight provided consistent oversight and hands-on assistance to both farmers. She visited both farms frequently and provided the agency partners with updates on the condition of the fields. When needed, Teri asked for technical assistance from the PMC, on such topics as irrigation rates, herbicides to use, and herbicide application rates and timing. An On-Farm Assessment and Seed Production worksheet was developed by the PMC to evaluate condition of the Alkali sacaton and Alkali muhly fields, to be used by the RC&D coordinator and the farmers (Attachments A and B).

In addition to RC&D's vigilance, Ramona of the Tucson PMC visited both farms twice, in April and July, for additional on-site assistance. Ramona's first visit was only weeks prior to the planting of the second species in May. Evidence of continued challenges by the farmers— lack of ownership and lack of experience— was apparent at each visit, but the opportunity for improvement, with the promise of hard work, was always present.

Uneven distribution of water across the Alkali sacaton field at Sunrise Acres caused some plants to stay small

Challenges encountered in 2007 at Sunrise Acres Farm in Pahrump were different from Moapa School's but still significant. New and consistent weed species continue to persist in the fields, despite the assertion by the farmers that they had been manually removing them. Noxious weeds, including Red brome, Bermuda grass and a recent occurrence of Tamarisk, threaten the viability of the harvest. Low and uneven irrigation rates, causing the plants to stay small, were addressed by the RC&D and the local NRCS field office in August with new higher volume sprinkler heads. Seed production increased, and although not enough to warrant transport of PMC equipment from Arizona, the ripe seed heads could not be resisted, and were hand harvested by Teri herself in

October. The fact that the farmer did not assist in this endeavor was troubling, and this lack of ownership confounds the success of this production.

September's harvest from Sunrise Acres of 23 lb of plant matter was sent to the PMC for cleaning. A total of 262g (0.6 lb) of seed was produced. A second hand harvest— of both species this time— was conducted by the RC&D and BLM employees in late November. Again, this effort was conducted without the assistance of the farmer. The increase in irrigation rates and seed yield, as demonstrated this fall, is promising. Accomplishments in weed control and overall proven ownership— thus ultimate success— of these fields will remain to be seen.

Alkali sacaton harvest (August 2007). Teri Knight could not be in the picture because she was busy being the

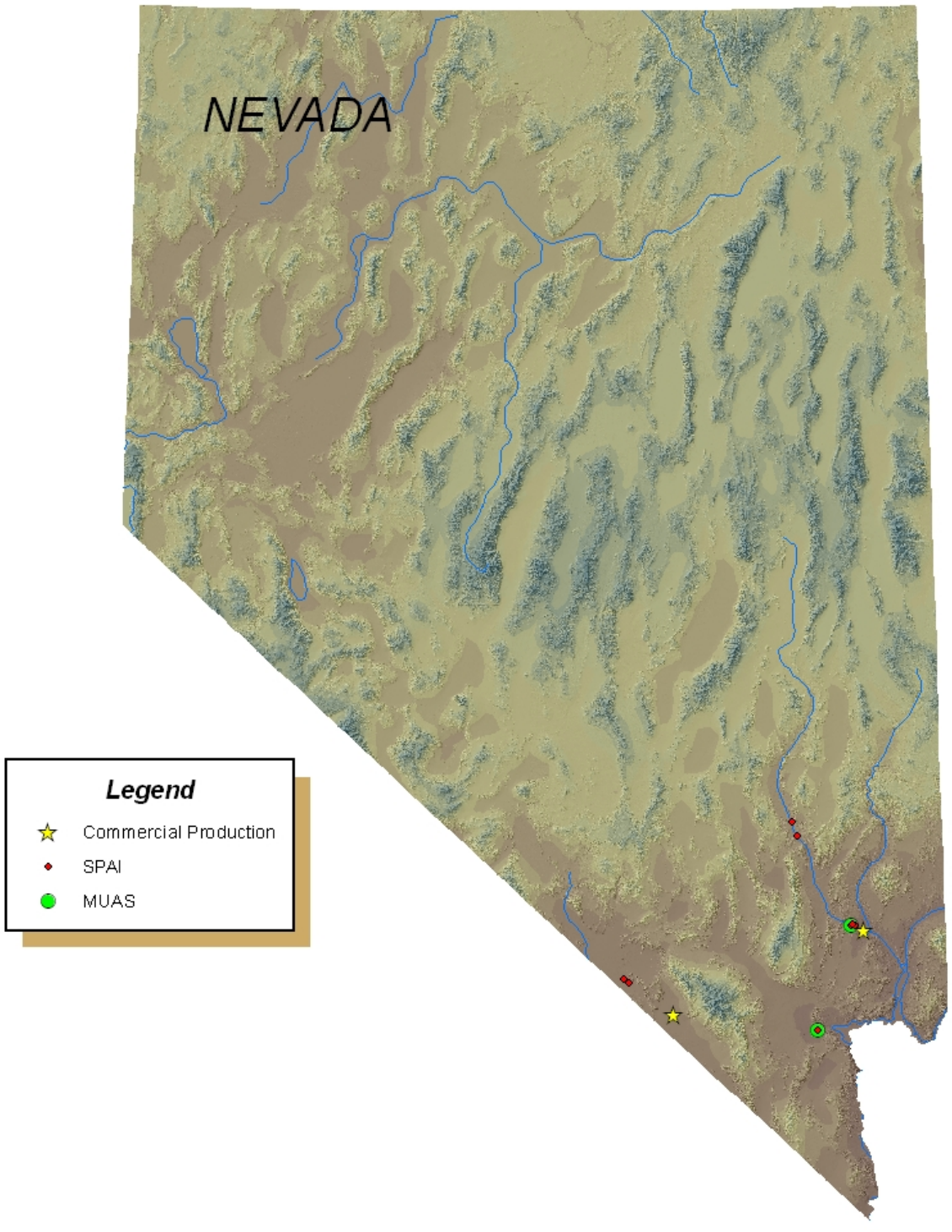
Reflection on the project

Alkali sacaton, after a year in commercial production, provided the project partners a chance to reflect on the three-year project as a whole. The opportunity to develop regional releases from a very unique environment such as the Mojave was invaluable to the understanding of species diversity within small geographic areas, and the importance of including as many collections of genetic material into the original seed mix as possible. The second phase of the project, the establishment of commercial growers, was also enlightening but made evident the challenges involved in the ultimate goal of the project, a dependable seed source available into the future.

A young scratchgrass plant survives the drought at the Tucson PMC (January 2008)

The lessons learned from this pilot project will be useful for related future endeavors as well as those beyond the scope of the project. Native seed production is not easy or as straight-forward as some may think. Future projects involving commercial native seed producers will involve close scrutiny in terms of previous experience, farm equipment already in possession, and examination of their current fields (and proven low tolerance to weeds). Enthusiasm is another critical element, but cannot replace experience. Over the next year, Sunrise Acres will continue to receive technical assistance, as needed. The Tucson PMC anticipates going to Pahrump in summer or fall 2008 for a first substantial harvest of both species- using the flail vac purchased last year. Hopefully after that, with personal ownership and perseverance, the farmers at Sunrise Acres will be producers all on their own. We will also continue to look for additional and promising growers for these two

species releases, Alkali sacaton and Scratchgrass, to ensure that riparian areas in southern Nevada will have an opportunity to be restored.


NEVADA
Legend
Commercial Production
SPAI
MUAS

THE UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
TUCSON PLANT MATERIALS CENTER
TUCSON, ARIZONA

AND

THE UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
LAS VEGAS FIELD OFFICE
LAS VEGAS, NEVADA

NOTICE OF RELEASE OF A SELECTION OF SCRATCHGRASS SELECTED CLASS OF GERMPLASM

The U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS), and the U.S. Department of the Interior, Bureau of Land Management (BLM) announce the release of a selected class of scratchgrass (*Sporobolus airoides* (Torr.) Torr.) developed for use in southern Nevada.

As a selected release, this germplasm will be referred to as Vegas Germplasm scratchgrass to document general collection location. It has been assigned the NRCS accession number 9092744. Vegas Germplasm is released as a selected class of certified seed.

This alternative release procedure is justified by the lack of existing commercial sources of scratchgrass developed specifically for the Mojave Desert of southern Nevada. Propagation material of this species is needed for ecosystem restoration and enhancement in southern Nevada. The potential for immediate use is high. Current released cultivars of scratchgrass were developed from other areas of species adaptation. The cultivar 'Saltalk' was collected from Erick, OK and 'Salado' from Claunch, NM.

Species:	*Sporobolus airoides* (Torr.) Torr.
Common Name:	scratchgrass
Plant Symbol:	SPAI
Accession Numbers:	9092744

Collection Site Information

Vegas Germplasm is a composite of 4 accessions collected from native scratchgrass stands in southern Nevada (Table 1). Plant materials were collected from distinct locations at the peripheries of southern Nevada to develop a population of scratchgrass with a broad genetic base and adapted to the range of conditions in southern Nevada.

Description

Scratchgrass is a native, long-lived, warm-season, perennial bunchgrass. It reaches heights of 20 to 40 inches (50-100 cm). The panicles, nearly half the length of the plant, are stiff and

slender on widely spreading branches. Spikelets diverge from the panicles and have one flower. Seed fall readily from the spikelet when mature. The species is a facultative halophyte, having a broad tolerance to salinity. Scratchgrass reproduces from seeds and tillers. It blooms from April to May, producing seed from late summer to October. Plants produce abundant seed that remain viable for many years, in fact seed germination is best after ripening for a period of several months. In natural settings seed usually germinate in July after a 9-month after-ripening period. Scratchgrass grows in soil textures ranging from sand to clay, usually with low organic matter. Scratchgrass may grow in saline or nonsaline soils, often occurring in pure, dense, stands. It is common in moist alkaline flats, due to its adaptation to soils containing high sodium chloride concentrations and soils containing mixtures of other salts such as bicarbonate and sulfate compounds. On saline soils it is commonly found as a primary or secondary invader. After establishment, it is tolerant of both drought and inundation by water.

Table 1. Accession number and origin of collections for Vegas Germplasm scratchgrass

Composite Accession Number	Accession Number	BLM Number	Collection Site	Site Name
9092500	9092497	NV-052-0077R	N 36° 42.651 N 114° 42.630	Moapa
	9092498	NV-052-0055R	N 36° 42.271 N 114° 41.311	
	9092499	NV-052-0036R	Moapa NWR	
9092503	9092501	NV-052-0107R	N 37° 18’ 43.3” N 115° 7’ 34.7”	Pahranagat
	9092502	NV-052-0106R	N 37° 13’ 58.4” N 115° 5’ 25.8”	
	9092508	NV-052-0037R	Pahranagat NWR	
9092506	9092504		Ash Meadows NWR	Ash Meadows
	9092505	NV-052-0119R	Ash Meadows NWR	
9092507	9092507	NV-052-0043R	Sacaton Canyon	Sacaton Canyon

Method of Selection

Vegas Germplasm was developed from collections made at nine distinct sites within Clark, Lincoln and Nye Counties in southern Nevada. Accessions were planted in a 0.5 ac field at the PMC in June 2005. Plugs were planted into a latin square design to maximize hybridization between accessions. An experimental unit consisted of 10 plants. Seed were harvested 3 times during the growing season with the Woodward Flail vac seed stripper. For species like scratchgrass with indeterminate flowering, this process allows for multiple

harvests throughout the growing season. Multiple harvests insure that germplasm is represented in the new population regardless of time of maturity. The seed from the 3 harvests were combined to produce the Vegas germplasm of scratchgrass.

Ecological Considerations

Vegas Germplasm scratchgrass is a composite of naturally occurring germplasm and has undergone minimal purposeful selection. Vegas Germplasm does not differ significantly in rate of spread, seed production, or vigor from naturally occurring scratchgrass. Vegas Germplasm spike dropseed was determined "OK to release" when evaluated through the "Worksheet for Conducting and Environmental Evaluation of NRCS Plant Releases".

Anticipated Conservation Use

The potential uses of Vegas Germplasm scratchgrass include restoration and rehabilitation of riparian systems, wildlife habitat improvement, restoration of disturbed areas, and for increasing plant diversity in areas along the Virgin River and other lands in the southern Nevada area.

Anticipated Area of Adaptation

Vegas Germplasm scratchgrass was developed for use in the Mojave desert of southern Nevada. Scratchgrass is found naturally growing in sandy to clay soils. It may grow in saline or nonsaline soils.

Availability of Plant Materials

Seed production will be maintained by the USDA-NRCS Tucson Plant Materials Center. Limited quantities of seed are available to seed producers for increase and to other interested parties as available.

References.

1. Aldon, Earl F. 1975. Establishing alkali sacaton on harsh sites in the Southwest. Journal of Range Management. 28(2): 129-132.
2. De Alba-Avila, Abraham; Cox, Jerry R. 1988. Planting depth and soil texture effects on emergence and production of three alkali sacaton accessions. Journal of Range Management. 41(3): 216-219.
3. Flora of North America Editorial Committee, eds. 2003. Flora of North America North of Mexico. Vol 25. New York and Oxford.
4. Gould, F.W. 1977. Grasses of southwestern United States. Univ. of Ariz. Press, Tucson, AZ.
5. Hickman, James C., ed. 1993. The Jepson manual: Higher plants of California. Berkeley, CA: University of California Press. 1400 p.
6. Jones, T.A. and D.A. Johnson. 1998. Integrating genetic concepts into planned rangeland seedings. Journal of Range Management 51: 594-606.

7. Kearney, T.H. and R.H. Peebles. 1969. Arizona flora. University of California Press, Berkely, CA.
8. Knipe, O. D. 1968. Effects of moisture stress on germination of alkali sacaton, galleta, and blue grama. Journal of Range Management. 21: 3-4.
9. Shiflet, Thomas N., ed. 1994. Rangeland cover types of the United States. Denver, CO: Society for Range Management. 152 p.
10. Thornburg, Ashley A. 1982. Plant materials for use on surface-mined lands. SCS-TP-157. Washington, DC: U.S. Department of Agriculture, Soil Conservation Service. 88 p.
11. USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

Prepared by:

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Mary E. Hershdorfer, USDA-NRCS Tucson Plant Materials Center, 3241 N. Romero Road, Tucson, Arizona 85705

Signatures for release of:

Moapa Germplasm Scratchgrass (*Muhlenbergia asperifolia*)

_____ _____

David McKay Date
Arizona State Conservationist
United States Department of Agriculture
Natural Resources Conservation Service
Phoenix, Arizona

_____ _____

Diane Gelburd Date
Director, Ecological Sciences Division
United States Department of Agriculture
Natural Resources Conservation Service
Washington, D.C.

_____ _____

Ted Angle Date
Nevada State Weed Program Coordinator
United States Department of the Interior
Bureau of Land Management
Reno, Nevada

THE UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
TUCSON PLANT MATERIALS CENTER
TUCSON, ARIZONA

AND

THE UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
LAS VEGAS FIELD OFFICE
LAS VEGAS, NEVADA

NOTICE OF RELEASE OF A SELECTION OF ALKALI SACATON SELECTED CLASS OF GERMPLASM

The U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS), and the U.S. Department of the Interior, Bureau of Land Management (BLM) announce the release of a selected class of alkali sacaton (*Sporobolus airoides* (Torr.) Torr.) developed for use in southern Nevada.

As a selected release, this germplasm will be referred to as Vegas Germplasm alkali sacaton to document general collection location. It has been assigned the NRCS accession number 9092744. Vegas Germplasm is released as a selected class of certified seed.

This alternative release procedure is justified by the lack of existing commercial sources of alkali sacaton developed specifically for the Mojave desert of southern Nevada. Propagation material of this species is needed for ecosystem restoration and enhancement in southern Nevada. The potential for immediate use is high. Current released cultivars of alkali sacaton were developed from other areas of species adaptation. The cultivar 'Saltalk' was collected from Erick, OK and 'Salado' from Claunch, NM.

Species:	*Sporobolus airoides* (Torr.) Torr.
Common Name:	alkali sacaton
Plant Symbol:	SPAI
Accession Numbers:	9092744

Collection Site Information

Vegas Germplasm is a composite of 4 accessions collected from native alkali sacaton stands in southern Nevada (Table 1). Plant materials were collected from areas within the southern Nevada area to develop a population of alkali sacaton with a broad genetic base and adapted to the range of conditions in southern Nevada.

Description

Alkali sacaton is a native, long-lived, warm-season, perennial bunchgrass. Height is from 20 to 40 inches (50-100 cm). The panicles, nearly half the length of the plant, are stiff and

slender on widely spreading branches. Spikelets diverge from the panicles and have one flower. Seed fall readily from the spikelet when mature. The species is a facultative halophyte, having a broad tolerance to salinity. Alkali sacaton reproduces from seeds and tillers. It blooms from April to May producing seed from late summer to October. Plants produce abundant seed that remain viable for many years. Seed germination is best when seed undergo an after ripening period of several months. In natural settings seed usually germinate in July after a 9-month after-ripening period. Alkali sacaton grows in soil textures ranging from sand to clay, usually with low organic matter. Alkali sacaton may grow in saline or nonsaline soils, often occurring in pure, dense, stands. It is common in moist alkaline flats, due to its adaptation to soils containing high sodium chloride concentrations and soils containing mixtures of other salts such as bicarbonate and sulfate compounds. On saline soils it is commonly found as a primary or secondary invader. After establishment, it is tolerant of both drought and inundation by water.

Table 1. Accession number and origin of collections for Vegas Germplasm spike dropseed.

Composite Accession Number	Accession Number	BLM Number	Collection Site	Site Name
9092500	9092497	NV-052-0077R	N 36° 42.651 N 114° 42.630	Moapa
	9092498	NV-052-0055R	N 36° 42.271 N 114° 41.311	
	9092499	NV-052-0036R	Moapa NWR	
9092503	9092501	NV-052-0107R	N 37° 18’ 43.3” N 115° 7’ 34.7”	Pahranagat
	9092502	NV-052-0106R	N 37° 13’ 58.4” N 115° 5’ 25.8”	
	9092508	NV-052-0037R	Pahranagat NWR	
9092506	9092504		Ash Meadows NWR	Ash Meadows
	9092505	NV-052-0119R	Ash Meadows NWR	
9092507	9092507	NV-052-0043R	Sacaton Canyon	Sacaton Canyon

Method of Selection

Vegas Germplasm was developed from collections made at nine distinct sites within Clark, Lincoln and Nye Counties in southern Nevada. Accessions were planted in a 0.5 ac field at the PMC in June 2005. Plugs were planted into a latin square design to maximize hybridization between accessions. An experimental unit consisted of 10 plants. Seed were harvested 3 times during the growing season with the Woodward Flail vac seed stripper. For

species like alkali sacaton with indeterminate flowering, this process allows for multiple harvests throughout the growing season. Multiple harvests insure that germplasm is represented in the new population regardless of time of maturity. The seed from the 3 harvests were combined to produce the Vegas germplasm of alkali sacaton.

Ecological Considerations

Vegas Germplasm alkali sacaton is a composite of naturally occurring germplasm and has undergone minimal purposeful selection. Vegas Germplasm does not differ significantly in rate of spread, seed production, or vigor from naturally occurring alkali sacaton. Vegas Germplasm spike dropseed was "OK to release" when evaluated through the "Worksheet for Conducting and Environmental Evaluation of NRCS Plant Releases".

Anticipated Conservation Use

The potential uses of Vegas Germplasm alkali sacaton include restoration and rehabilitation of riparian systems, wildlife habitat improvement, restoration of disturbed areas, and for increasing plant diversity in areas along the Virgin River and other lands in the southern Nevada area.

Anticipated Area of Adaptation

Vegas Germplasm alkali sacaton was developed for use in the Mojave desert of southern Nevada. Alkali sacaton is found naturally growing in sandy to clay soils. It may grow in saline or nonsaline soils.

Availability of Plant Materials

Seed production will be maintained by the USDA-NRCS Tucson Plant Materials Center. Limited quantities of seed are available to seed producers for increase and to other interested parties as available.

References.

12. Aldon, Earl F. 1975. Establishing alkali sacaton on harsh sites in the Southwest. Journal of Range Management. 28(2): 129-132.
13. De Alba-Avila, Abraham; Cox, Jerry R. 1988. Planting depth and soil texture effects on emergence and production of three alkali sacaton accessions. Journal of Range Management. 41(3): 216-219.
14. Flora of North America Editorial Committee, eds. 2003. Flora of North America North of Mexico. Vol 25. New York and Oxford.
15. Gould, F.W. 1977. Grasses of southwestern United States. Univ. of Ariz. Press, Tucson, AZ.
16. Hickman, James C., ed. 1993. The Jepson manual: Higher plants of California. Berkeley, CA: University of California Press. 1400 p.

17. Jones, T.A. and D.A. Johnson. 1998. Integrating genetic concepts into planned rangeland seedings. Journal of Range Management 51: 594-606.

18. Kearney, T.H. and R.H. Peebles. 1969. Arizona flora. University of California Press, Berkely, CA.

19. Knipe, O. D. 1968. Effects of moisture stress on germination of alkali sacaton, galleta, and blue grama. Journal of Range Management. 21: 3-4.

20. Shiflet, Thomas N., ed. 1994. Rangeland cover types of the United States. Denver, CO: Society for Range Management. 152 p.

21. Thornburg, Ashley A. 1982. Plant materials for use on surface-mined lands. SCS-TP-157. Washington, DC: U.S. Department of Agriculture, Soil Conservation Service. 88 p.

22. USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

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Mary E. Hershdorfer, USDA-NRCS Tucson Plant Materials Center, 3241 N. Romero Road, Tucson, Arizona 85705

Bruce Munda, USDA-NRCS, 3241 N. Romero Road, Tucson, Arizona 85705

Signatures for release of:

Vegas Germplasm Alkali Sacaton (*Sporobolus airoides*)

_____ _____

David McKay Date
Arizona State Conservationist
United States Department of Agriculture
Natural Resources Conservation Service
Phoenix, Arizona

_____ _____

Diane Gelburd Date
Director, Ecological Sciences Division
United States Department of Agriculture
Natural Resources Conservation Service
Washington, D.C.

_____ _____

Ted Angle Date
Nevada State Weed Program Coordinator
United States Department of the Interior
Bureau of Land Management
Reno, Nevada

Santa Rita Experimental Range: Buffelgrass Control in PMC Exclosure

STUDY NUMBER: AZPMC-T-0612-IN

Soon after the Tucson Plant Materials Center was established in the 1930s, a 13 ac exclosure on the Santa Rita Experimental Range (SRER) was provided to test plant materials from the Center. The site is conveniently located near Sahuarita, which is approximately 30 miles south of the Center.

The SRER is a research facility established in 1903 to study the effects of grazing and livestock production on semidesert rangelands. It was once administered and managed by the US Forest Service, and in the early 1990's management was transferred to the University of Arizona's College of Agriculture. A good working relationship was established between these organizations and the Tucson PMC, and all plantings conducted were a result of collaboration. This plot was used year after year with a variety of different materials, disked, and used again in following years, until the mid-80s. This period was characterized by active interest in "improvement of the range" – be it native or exotic – whatever would establish in these arid grasslands and provide good nutrition to wildlife and cattle.

In 1985 a plot of Buffelgrass (*Cenchrus ciliaris*), an exotic grass from South Africa, was planted in the center of the exclosure as one of 20 accessions of plant materials to be tested. In following years, the Buffelgrass plot, once 8 ft wide by 205 ft long, began to spread. Soon after this planting, use of the plot by the PMC for plantings diminished, but was occasionally monitored. In 2001 it was reported, "Buffelgrass has invaded and taken over most of the center of the site." (Bruce Munda, SRER log book, 1/31/2001)

In successive years a monoculture has covered over half the exclosure as well as beyond the fence line. Buffelgrass has not only spread at this site, but in recent years has noticeably spread across southern Arizona, particularly along roadsides and southern facing hillsides. Meanwhile, the Tucson PMC has changed its purpose from "improvement" of rangelands to "restoration" of rangelands, with exclusive use of native, preferrably local or regional, materials.

2006 Buffelgrass Control

In August 2006, the University of Arizona and the Tucson PMC agreed it was time to contain the buffelgrass infestation in the test plot. In three days of spraying over a period of a month, using a variety of equipment and multiple individuals, the infestation was sprayed. On the first day, the tractor with an 8 ft boom was used for spraying, requiring a driver and two additional people for directing the tractor movement to assure good coverage. 130 gallons of 5% Roundup solution was used to

Jace sprays the infestation of Buffelgrass at SRER plot in 2006

cover approximately 7 ac, the area of densest infestation. The infestation was located with GPS, which was centered in the exclosure, but also spread to nearby washes and roads. For the following two days of work only ATV and backpacks were used to spray the smaller patches.

The first two visits occurred during the monsoon period, when the plants were growing vigorously. By the third visit a month later, the Buffelgrass was yellowing, entering dormancy. The first two days of spraying killed the Buffelgrass but the third visit was inconclusive.

Ramona rejoices at her success two weeks after spraying Buffelgrass (June 2006)

2007 Buffelgrass Control

Early in April 2007, a visit to the SRER revealed two striking observations. The first was color throughout the plot: many native winter forbs were establishing in the plot. It was also clear that the third spray day in September had not likely been as successful as the previous two. Spraying during the height of buffelgrass growth had left the vegetation grey (dead), but spraying following the beginning stages of dormancy only turned many plants a suspicious straw color. It was not until the following visit in June, still early in the growing season and too dry to begin spraying, did the yellowed plants reveal life in the form of green leaves.

A patch of straw-colored buffelgrass with a sprig of green life, surrounded by dead buffelgrass (June 2007)

In August, after the summer rains, the first of two spray days took place. This year the plot was a verdant green with needle grama (*Bouteloua aristidoides*) covering the ground in the open areas, feather fingergrass (*Chloris virgata*) came up under the drip line of trees, and young buffelgrass plants as seedlings covered the same area as it had the previous year. The seedbank of previous years had plenty of seed left to germinate. The treatment plan in this

Needle grama grows densely in the open areas.

second year was to use the tractor in the same central infestation as last year, as well as the smaller patches surrounding it. The success with the previous tractor work made it clear that spraying with the tractor was preferable. Only the individual plants and small satellite patches outside the fenced plot were sprayed with the ATV. Many flourishing patches of native plants, particularly Arizona cottontop, were avoided. Three (1000 ft^2) experimental plots for testing a grass-specific herbicide (Fluazifop) were marked with rebar up against the western-fence line.

The truck and trailer carrying the tractor were brought to the plot, followed by a truck with four 30 gal drums of water and several containers of Round up, dish soap and blue dye. The tractor's spray tank was refilled once. The ATV's 30-gal tank was refilled multiple times. A two-person crew used the ATV, while the tractor required only one person.

In one day the entire area was covered. The experimental plots were sprayed with the grass-

Jace sprays the primary infestation with the tractor (above). Leslie sprays a smaller patch with the ATV.

An experimental plot for grass-specific herbicide did not kill the buffelgrass (September 2007).

specific herbicide; however expectations were low because the grasses at this point were larger than anticipated. Grass-specific herbicide is more effective on seedlings, less so on mature plants.

In September a reconnaissance day was scheduled to visit the results of the previous spraying, and to follow up by spraying any missed individual patches or plants. The ATV and several back packs were transported, along with water and chemicals. Few patches needed spraying, however the experimental plots with grass-specific herbicide appeared unaffected. Fears were confirmed that the treatment did not work on plants at that stage of maturity.

The second year of spraying required treatment of similar acreage, but this is to be expected with an invasive plant such as buffelgrass. The seedbed has been establishing for the past 20 years, and the dead plants from 2006 left space and resources for establishment of seedlings the following year. The second year required less effort however, as the spraying of young plants as opposed to decadent 4 ft tall plants, cut the work by over half. These young plants were not quite young enough to make the grass-specific herbicide effective, however if attempted earlier, at a younger stage of growth, this treatment may be effective. The fact that in the second year feather fingergrass was found under the tree that previously had only buffelgrass was encouragement enough to feel success had been achieved. If greenhouse experiments on buffelgrass seed longevity of 3 years prove correct, then after a following year of spraying, we expect to see a marked decrease in the infestation by 2009.

Ramona displays the feather finger grass in 2007 growing under the mesquite tree sprayed in 2006.

Evaluation of Accessions of Sideoats Grama from Southeastern Arizona (MLRA 41)

STUDY NUMBER: AZPMC-P-0601-CR

STUDY NUMBER: AZPMC-T-0601-CR

Description

The sideoats grama (*Bouteloua curtipendula* [Mitchx.] A. Gray) initial evaluation planting (IEP) consists of 36 accessions, collected from Major Land Resource Area (MLRA) 41 the Southeastern Arizona Basin and Range in southeastern Arizona and southwestern New Mexico. This area is a transition between the Chihuahuan and the Sonoran Desert regions. The plant selection study is designed to evaluate the genetic diversity among populations of sideoats grama in this area. The technology development study will evaluate and develop production techniques and develop a protocol for commercial use of any potential release.

Objectives of these studies are:

1. Evaluate the diversity among accessions in this collection.
2. Evaluate phenotypic characters of accessions in this collection.
3. Develop production protocols.
4. Determine yield potential of seed and forage.
5. Produce a selected release for MLRA 41.

Duration of Study: 2006 through 2010

Study Leaders: Ramona Garner and Mary Hershdorfer

Location: Tucson Plant Materials Center, Tucson, Arizona

Introduction

Sideoats grama is a native, warm season perennial bunchgrass (Kearney et.al., 1960). Leaves are bluish green with heights of 3 to 39 inches (50-160 mm) and in southern Arizona occur in large clumps arising from a single root system (Kearney et. al, 1960). The stems occur in large or small clumps and are stiff and upright. The blades are usually narrow, up to 0.9 inches (2.5 mm) wide. Panicles have 12-80 branches, averaging 2-7 spikelets per branch. The glumes and lemmas are usually bronze or straw-colored to green but may occur in various shades of purple. The anthers are usually yellow or orange, but are occasionally red or purple. The chromosome number for *Bouteloua curtipendula* var. *caespitosa* is reported to be 2n = 58-103. (Flora of North America, 2003)

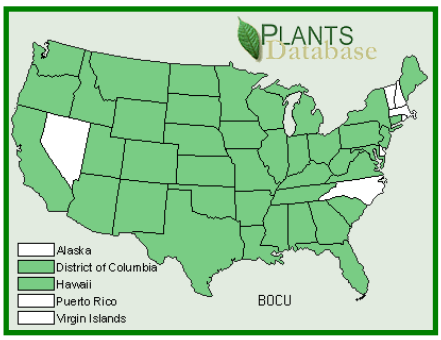


Fig. 1. Distribution of Sideoats Grama in North America

Sideoats grama is one of the most widely distributed warm season grass in the United States (Gould, 1979) (Fig. 1). In the West, sideoats grama generally occurs in loose, sandy or rocky, well drained limey soils. It is a major species in the desert grasslands of the

southwest. Sideoats grama most often occurs as a component of diverse grassland. It rarely occurs as a monoculture (Newell, et.al., 1962; Ruhle and Young, 1997).

There are two recognized varieties of sideoats grama, *Bouteloua curtipendula* var. *curtipendula* and *Bouteloua curtipendula* var. *caespitosa*. These varieties are most often distinguished by their area of occurrence. *Bouteloua curtipendula* var. *curtipendula* is distinguished by its ability to spread by rhizomes and is found in the northern range of the species. Sideoats grama in the southwestern United States is primarily *Bouteloua curtipendula* var. *caespitosa* (Smith, 1998). None of the accessions in this study are rhizomonous and thus are considered to be *Bouteloua curtipendula* var. *caespitosa*.

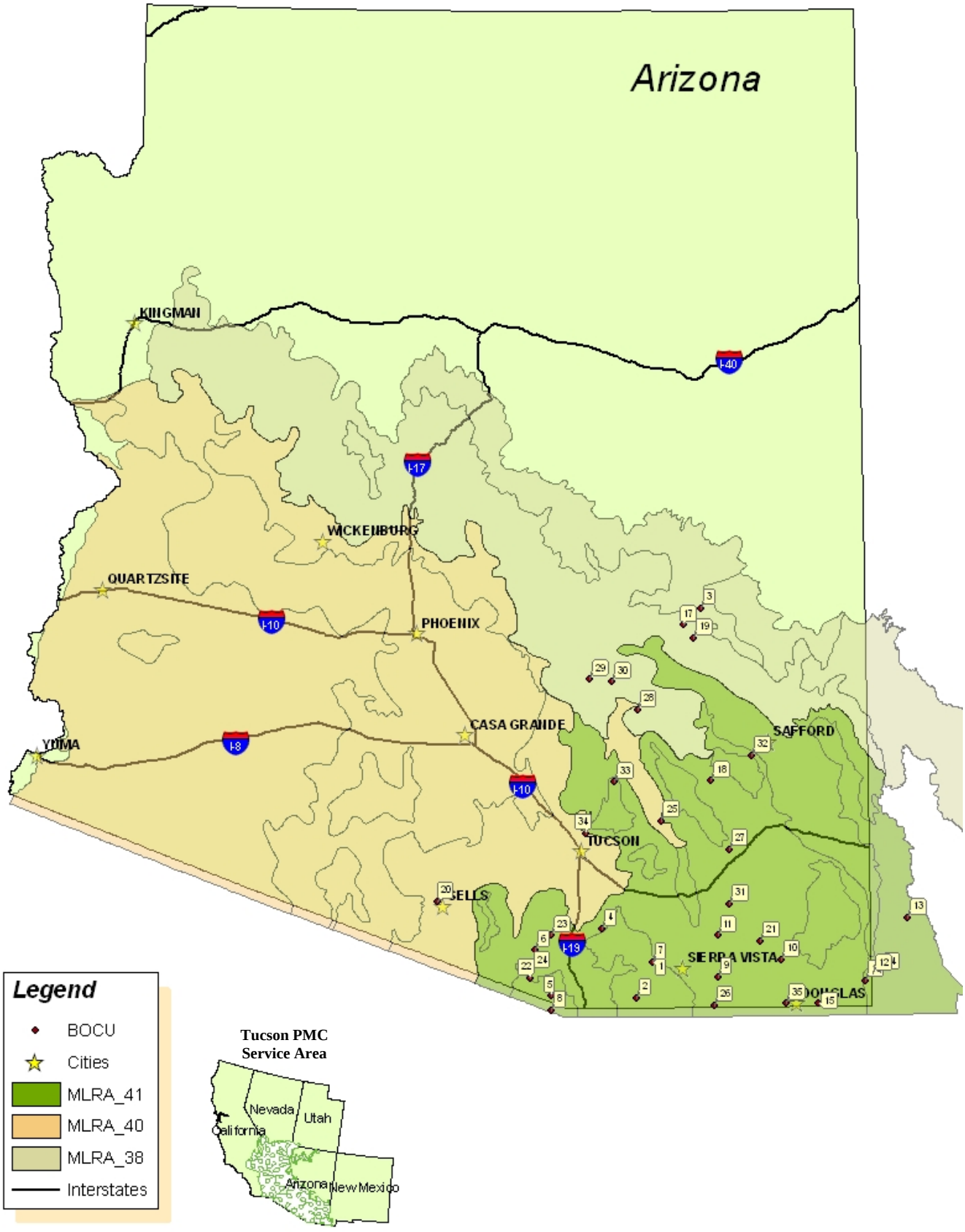
Bouteloua curtipendula var. *caespitosa* is considered to be apomictic through apospory (Gould, 1959; Mohamed and Gould, 1966). In apomictic species seed is formed asexually. The embryo develops in the ovary, as in sexually reproducing plants, but the embryo is formed without union of a sperm and egg. Even though this variety of sideoats does not reproduce sexually there is evidence of extensive variation within and among stands (Smith, 1998).

Materials and Methods

Thirty six accessions from MLRA 41 (Table 1) were grown in 35mm Jiffy forestry pellets in the greenhouse for 6 weeks. They were planted in July 2006 into a randomized complete block design (RCB)with 8 replications. Each experimental unit consists of 10 individual plants. Extra plants and accessions were used to fill in the field. Plugs were planted into the field 18 inches apart with 40 inch centers. Extra accessions were planted at the end of the plot to fill out the field. A pre-plant application of 100 lbs/acre of ammonium phosphate (11-48-0 $[NH_4)_3PO_4]$) was applied and the planting is irrigated as needed. In 2007 seed were collected from a sample of the total field (4 of the rows) for evaluating seed quality/germination between the accession. Approx. 500 seed per accession were harvested from the middle 6 plants of each 8 plant unit. Counted exactly using seed counter for 100 seeds, to be tested in greenhouse experiment planned for next year.

Results

In future growing seasons the accessions will be evaluated for characters such as size, flowering date, germination and vigor. Agronomic techniques will be evaluated to determine yield potential of seed and forage.



Location of Collections in Sideoats Grama Studies

Table 1. Accession number and collection location of 36 accessions in initial evaluation of Sideoats grama.

Number	Accession Number	Collection Location	Number	Accession Number	Collection Location
1	9092528	-110.5019 31.5901	19	9092705	-110.10110 32.6214
2	9092550	-110.6040 31.3874	20	9092718	-110.2139 33.4317
3	9092551	-110.1578 33.6033	21	9092737	-111.9331 31.9331
4	9092579	-110.99142 33.14354	22	9092519	-109.7803 31.7072
5	9092581	-110.8326 31.7811	23	9092588	-111.3131 31.5000
6	9092582	-111.1728 31.3992	24	9092613	-111.1711 31.7442
7	9092599	-111.2792 31.6597	25	9092616	-111.3078 31.5381
8	9092604	-110.5019 31.5901	26	9092641	-110.4411 32.3958
9	9092623	-111.1711 31.3175	27	9092518	-110.0934 31.3439
10	9092651	-110.0664 31.5033	28	9092555	-109.9865 32.2312
11	9092654	-109.6467 31.5997	29	9092553	-110.5941 33.0269
12	9092660	-110.0661 31.7411	30	9092759	-110.9177 33.2013
13	9092667	-109.0356 31.5111	31	9092580	-110.7668 33.1862
14	9092672	-108.8011 31.8253	32	9092538	-109.9855 31.9191
15	9092674	-108.9850 31.5169	33	9092517	-109.8280 32.7613
16	9092682	-109.3992 31.3508	34	9092521	-110.7500 32.6167
17	9092694	-109.0908 31.4747	35	9092520	-110.9461 32.3252
18	9092704	-110.2814 33.5078	36	9092578	-109.6167 31.3500

Literature:

Bashaw, E.C. 1980. Apomixis and its Application in Crop Improvement. p. 45-63. *In* W. R. Fehr and H. H. Hadley (ed.) Hybridization in Crop Plants. ASA, CSSA and SSSA, Madison, WI.

Flora of North America, Vol 25, 2003. Ed. Barkworth, M.E., K.M. Capels, S. Long, and M.B. Piep, Oxford University Press, New York.

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Hitchcock, A.S. 1951. Manual of the Grasses of the United States. Misc. Publ. No. 200 Washington, DC; U.S. Department of Agriculture, Agricultural Research Administration.

Kearney, T.H., R.H. Peebles, J.T. Howell and E. McClintock. 1960. Arizona Flora. 2nd ed. Berkeley, CA; University of California Press.

Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean and the Pacific Basin. 2006. USDA Handbook 296. USDA-Natural Resources Conservation Service. Washington, DC.

Evaluation of Accessions of Plains Lovegrass from Southeastern Arizona (MLRA 41)

STUDY NUMBER: AZPMC-P-0603-CR

STUDY NUMBER: AZPMC-T-0603-CR

Description

The plains lovegrass (*Eragrostis intermedia* A.S. Hitchcock) initial evaluation planting (IEP) consists of 30 accessions, collected from Major Land Resource Area (MLRA) 41 the Southeastern Arizona Basin and Range in southeastern Arizona and southwestern New Mexico. This area is a transition between the Chihauahuan and the Sonoran Desert regions. The plant selection study is designed to evaluate the genetic diversity among populations of Plains lovegrass in this area. The technology development study will evaluate and develop production techniques and develop a protocol for commercial use of any potential release.

Objectives of these studies are:

1. Evaluate the diversity among accessions in this collection.

2. Evaluate phenotypic characters of accessions in this collection.

3. Develop production protocols.

4. Determine yield potential of seed and forage.

5. Produce a selected release for MLRA 41.

Duration of Study: 2006 through 2010

Study Leaders: Ramona Garner and Mary Hershdorfer

Location: Tucson Plant Materials Center, Tucson, Arizona

Introduction

Plains lovegrass is a native, warm season perennial bunchgrass (Kearney et.al., 1960). Seed stalks are wiry and erect with heights of 1.2 to 3.5 inches (30-90 mm) (Kearney et. al, 1960). The leaf blades are usually narrow and up to 12 to 35 inches (10-25 cm) long. The inflorescence is an erect, diffuse, panicle 6 to 14 inches (15-35 cm) long. The spikelets have 3 to 9 flowers (Hitchcock, 1951). The seed is very small rectangular-prismatic and reddish brown. Plains lovegrass has had various chromosome numbers reported; 2n = ca. 54, 60, 72, ca., 74, 80, 100, 120. (Flora of North America, 2003)

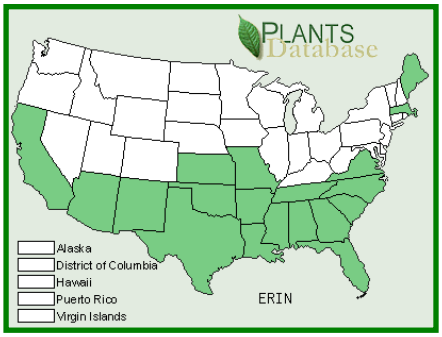

Fig. 1. Distribution of plains lovegrass in North America

Plains lovegrass occurs from Florida west to Arizona and extends north into Missouri and Kansas and south into scattered localities in Central America (Gould, 1979) (Fig. 1).

Plains lovegrass occurs on clay, sandy and rocky soils and often on disturbed sites, at 0 to 6069 feet (0 to 1850 m) elevation. In Arizona plains lovegrass occurs at elevations from 3,800 to 6,000 feet (1066 to 1800 m). Plains lovegrass will grow in most soil textures

(Canfield, 1948 and Frost and Smith, 1991). In southern Arizona it is most productive on sandy and sandy loam soils with poorly developed profiles and least productive on shallow, rocky soils. Plains lovegrass often grows in areas where annual precipitation is bimodal, with a wet season in winter and another in summer, when the bulk of the forage is produced. Mean annual precipitation in areas where plains lovegrass grows productively usually exceeds 15 inches (400 mm). (Wallmo, 1955)

Plains love grass produces quality forage on the grazing lands of Arizona and New Mexico (Gould, 1977 and Hitchcock, 1951). Because of its high seed stalk to forage ratio it does not produce a lot of forage. Plains lovegrass is considered to provide forage that is intermediate in preference to cattle. It is often heavily grazed since it is often the first species to green up in spring. In areas rested from grazing, Plains lovegrass increases, but decreases on areas where grazing occurs.

Materials and Methods

Twenty nine accessions from MLRA 41 (Table 1) were grown in 35mm Jiffy forestry pellets in the greenhouse for 6 weeks. They were planted in July 2006 into a randomized complete block design (RCB)with 9 replications. Each experimental unit consists of 8 individual plants. Plugs were planted into the field 18 inches apart with 40 inch centers. Extra accessions were planted at the end of the plot to fill out the field. A pre-plant application of 100 lbs/acre of ammonium phosphate (11-48-0 $[NH_4)_3PO_4]$) was applied and the planting is irrigated as needed.

Results

In future growing seasons the accessions will be evaluated for characters such as size, flowering date, germination and vigor. Agronomic techniques will be evaluated to determine yield potential of seed and forage.

It appears that the lack of irrigation in 2007 (well repair) may have caused the loss of this planting. However, seed was harvested in 2006 and may be used to reestablish the planting in 2008.

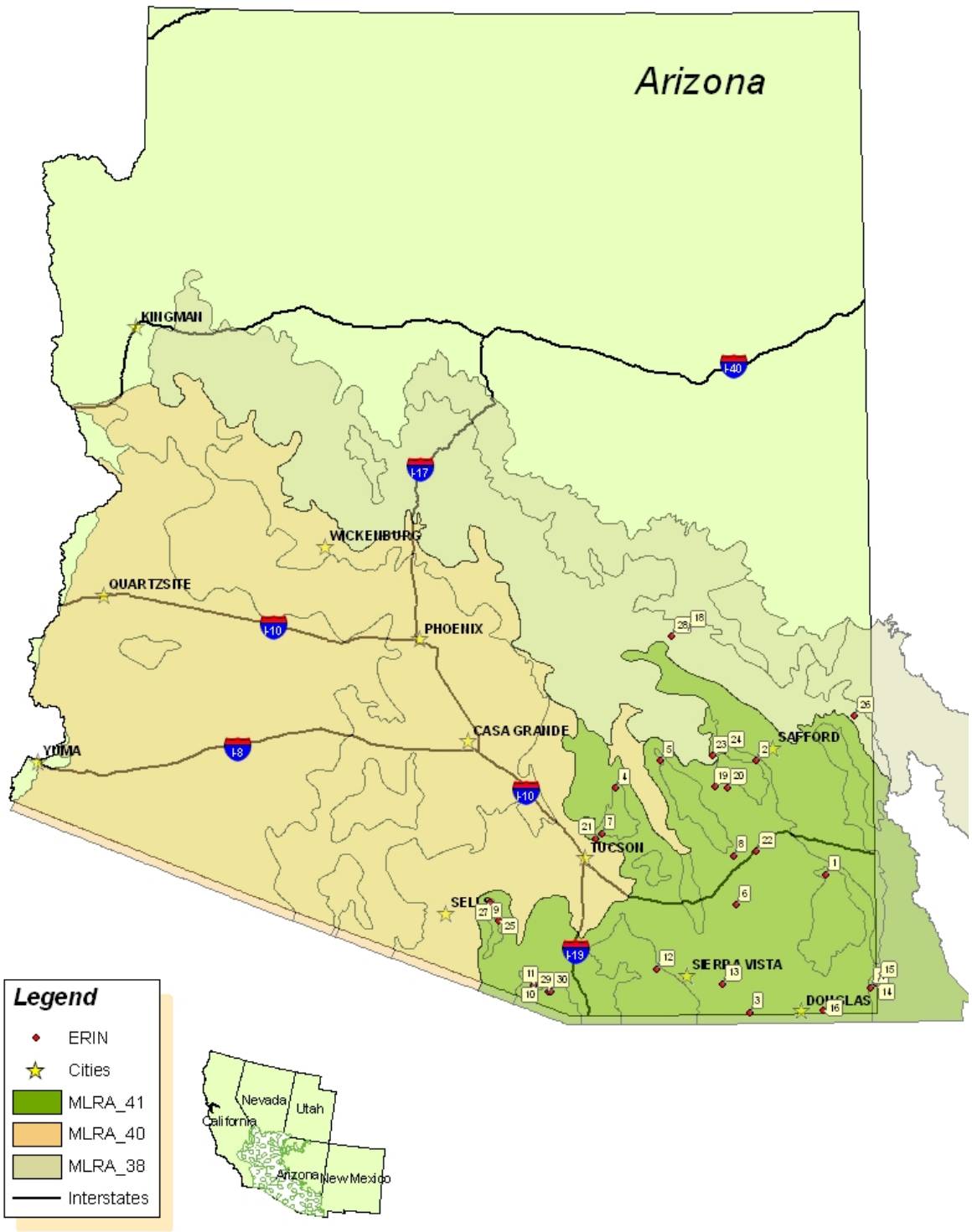
Arizona
KINGMAN
WICKENBURG
QUARTZSITE
PHOENIX
YUMA
CASA GRANDE
TUCSON
SAFFORD
SIERRA VISTA
DOUGLAS
I-40
I-17
I-10
I-8
I-19
Legend
ERIN
Cities
MLRA_41
MLRA_40
MLRA_38
Interstates
Nevada
Utah
California
Arizona
New Mexico

Table 1. Accession number and collection location of 30 accessions in initial evaluation of Plains lovegrass.

Number	Accession Number	Collection Location	Number	Accession Number	Collection Location
1	9092484	-109.3711 32.1175	16	9092686	-109.3992 31.3508
2	9092485	-109.8257 32.7662	17	9092692	-109.0908 31.4747
3	9092486	-109.8892 31.3439	18	9092703	-110.2814 33.5106
4	9092487	-110.7667 32.6167	19	9092709	-110.1011 32.6214
5	9092496	-110.4697 32.7712	20	9092716	-110.0214 32.6161
6	9092535	-109.9667 31.9500	21	9092743	-110.9000 32.3333
7	9092543	-110.8612 32.3607	22	9063991	-109.8320 32.2529
8	9092563	-109.9865 32.2312	23	9058812	-110.1160 32.7951
9	9092573	-111.6147 31.9585	24	9058768	-110.0306 32.8240
10	9092586	-111.3047 31.5089	25	9058769	-111.5469 31.8636
11	9092587	-111.3131 31.5000	26	9058770	-109.1610 33.0124
12	9092600	-110.5019 31.5901	27	9058806	-111.6067 31.9736
13	9092647	-110.0664 31.5033	28	9058771	-110.3846 33.4737
14	9092671	-109.0517 31.4978	29	9047438	-111.2167 31.4667
15	9092673	-109.0356 31.5111	30	9047439	-111.2000 31.4667

Literature:

Bashaw, E.C. 1980. Apomixis and its Application in Crop Improvement. p. 45-63. *In* W. R. Fehr and H. H. Hadley (ed.) Hybridization in Crop Plants. ASA, CSSA and SSSA, Madison, WI.

Canfield, R.H. 1948. Perennial grass composition as an indicator of Southwestern mixed grass ranges. Ecology. 29: 190-204.

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Frost, W.E. and E.L. Smith. 1991. Biomass productivity and range condition on range sites in southern Arizona. Journal of Range Management. 44(1): 64-67.

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Kearney, T.H., R.H. Peebles, J.T. Howell and E. McClintock. 1960. Arizona Flora. 2nd ed. Berkeley, CA; University of California Press.

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Wallmo, O.C. 1955. Vegetation of the Huachuca Mountains, Arizona. American Midland Naturalist. 54: 466-480.

Evaluation of Accessions of Bush Muhly from Major Land Resource Areas 40 and 41

STUDY NUMBER: AZPMC-P-0602-CR

STUDY NUMBER: AZPMC-T-0602-CR

STUDY NUMBER: AZPMC-P-0701-CR

Description

The Bush muhly (*Muhlenbergia porteri* Scribn. ex Beal) initial evaluation plantings (IEP) consists of 14 accessions, collected from Major Land Resource Area (MLRA) 41 the Southeastern Arizona Basin and Range in southeastern Arizona and southwestern New Mexico and 23 collections from MLRA 40 the Sonoran Basin and Range in southwestern Arizona. Major Land Resource Area 41 is a transition between the Chihauahuan and the Sonoran Desert region and MLRA 40 is the Sonoran Desert region. The plant selection studies are designed to evaluate the genetic diversity among populations of bush muhly in this area. The technology development studies will evaluate and develop production techniques and develop a protocol for commercial use of any potential release.

Objectives of these studies are:

1. Evaluate the diversity among accessions in this collection.

2. Evaluate phenotypic characters of accessions in this collection.

3. Develop production protocols.

4. Determine yield potential of seed and forage.

5. Produce a selected release for MLRA 41 and MLRA 40.

Duration of Study: 2006 through 2010

Study Leaders: Ramona Garner and Mary Hershdorfer

Location: Tucson Plant Materials Center, Tucson, Arizona

Introduction

Bush muhly is a native, drought resistant, warm season perennial bunchgrass (Kearney et.al., 1960). Seed stalks are slender, wiry, abruptly bent, multi-branched, with many nodes and short internodes with heights of 9.8 to 39 inches (25-100 cm) (Gould, 1979). The inflorescence is 1.6 to 5.5 inches (4-14 cm) long and 2.4 to 5.9 inches (6-15 cm) wide and usually purple at maturity. The seed is 0.07 to 0.09 inches (2-2.4 mm), oblong, compressed and yellowish-brown. Chromosome numbers reported for bush muhly are 2n = 20, 23, 24, 40. (Flora of North America, 2003)

Bush Muhly generally occurs in low elevation semi-desert and desert grasslands. It occurs on rocky or sandy sites on lower plains, dry mesas, canyons, foothills and open roadsides from 760 to 4,300 feet (230-1300 m).

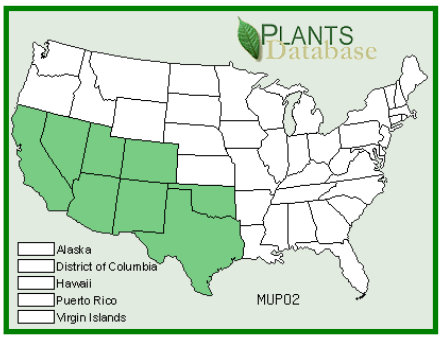


Fig. 1. Distribution of bush muhly in North America

(Gould, 1979). Bush muhly originally existed in extensive stands, but due to its preference by cattle is now generally found growing under the protection of shrubs (Welsh, 1976). Bush muhly may decrease greatly on heavily grazed rangeland, but may be a substantial component of mesa rangelands where they are in the process of recovery.

Materials and Methods

Eight accessions from MLRA 41 (Table 1) were grown in 35mm Jiffy forestry pellets in the greenhouse for 6 weeks. They were planted in July 2006 into a randomized complete block design (RCB) with 18 replications. Each experimental unit consists of 8 individual plants. Plugs were planted into the field 18 inches apart with 40 inch centers. Extra accessions were planted at the end of the plot to fill out the field. A pre-plant application of 100 lbs/acre of ammonium phosphate (11-48-0 [$NH_4)_3PO_4$]) was applied and the planting is irrigated as needed. Twenty-three accessions from MLRA 40 were planted in the same manner in 2007.

Results

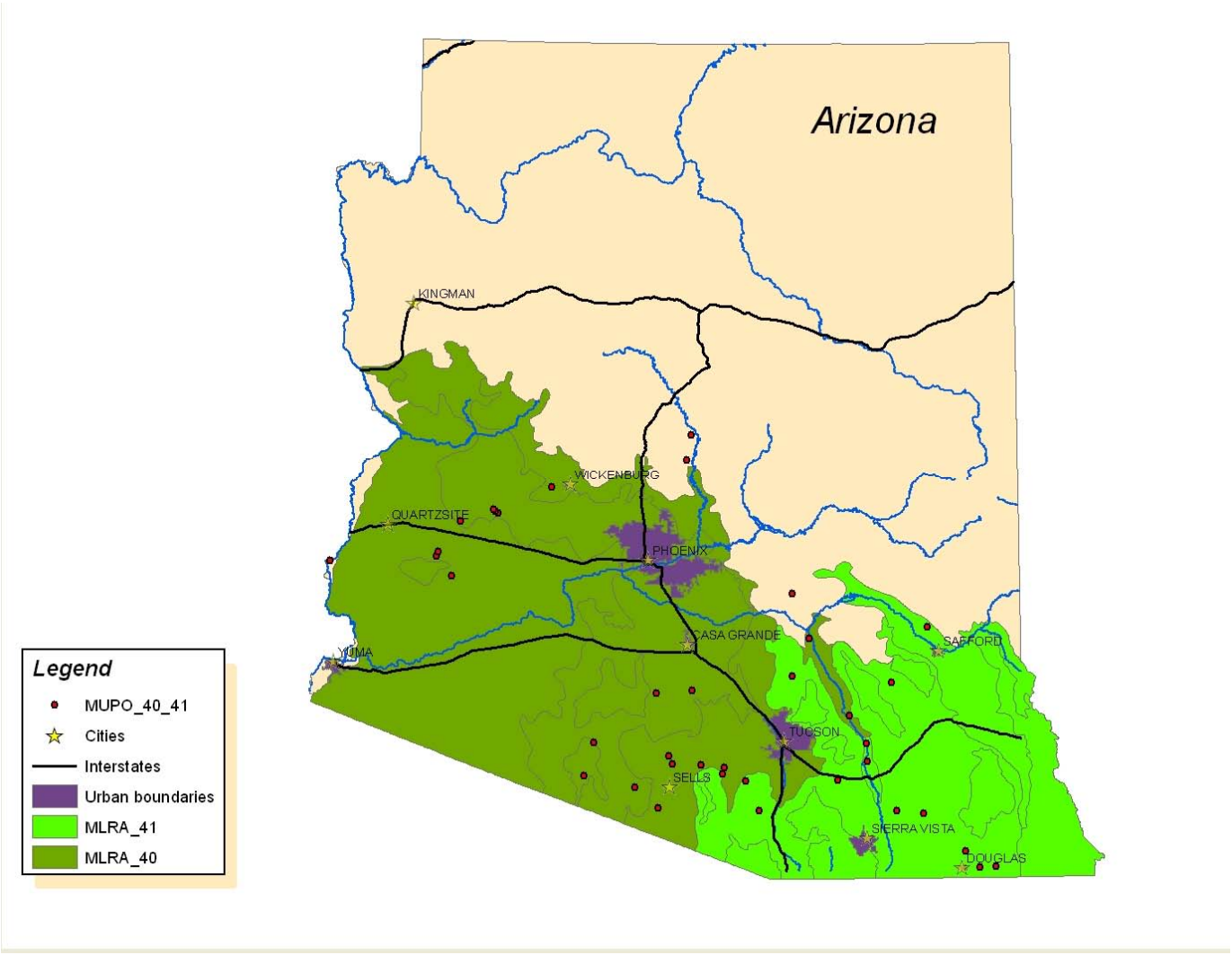
In future growing seasons the accessions will be evaluated for characters such as size, flowering date, germination and vigor. Agronomic techniques will be evaluated to determine yield potential of seed and forage.

Table 1. Accession number and collection location of 14 accessions in MLRA 41 evaluation of Bush muhly.

Number	Accession Number	Collection Location
1	9092494	-109.8482 31.7219
2	9092495	-109.7999 32.9979
3	9092574	-109.5148 31.4598
4	9092594	-111.2792 31.6597
5	9092621	-111.1711 31.7442
6	9092626	-110.2942 32.0792
7	9092631	-110.3061 32.2064
8	9092636	-110.4411 32.3958
9	9092666	-110.0661 31.7411
10	9092680	-109.3992 31.3508
11	9092708	-110.1011 32.6214
12	9092721	-111.6389 32.0586
13	9092727	-110.5331 31.9542
14	9092734	-110.5611 31.9331

Table 2. Accession number and collection location of 23 accessions in MLRA 40 evaluation of Bush muhly.

Number	Accession Number	Collection Location
1	9092749	-110.9031 33.2303
2	9092750	-111.4622 31.9942
3	9092751	-110.7647 32.9250
4	9093909	-112.5814 31.9747
5	9093910	-111.9800 31.7572
6	9093912	-112.5053 32.2014
7	9093915	-111.4533 32.0411
8	9093929	-111.8708 32.0603
9	9093933	-1118967 32.1167
10	9093936	-111.7339 34.3214
11	9093945	-110.9039 32.6686
12	9093946	-111.7733 34.1475
13	9093949	-113.6214 33.7019
14	9093953	-114.6814 33.4047
15	9093954	-113.6825 33.3258
16	9093957	-112.8803 33.9481
17	9093963	-113.3183 33.7589
18	9093965	-113.3389 33.7733
19	9093969	-113.3519 33.7839
20	9093975	-113.8142 33.4553
21	9093977	-113.8008 33.4844
22	9093982	-112.0028 32.5475
23	9093983	-111.7147 32.5647


Arizona
KINGMAN
WICKENBURG
QUARTZSITE
PHOENIX
CASA GRANDE
SAFFORD
YUMA
TUCSON
SELLS
SIERRA VISTA
DOUGLAS
Legend
MUPO_40_41
Cities
Interstates
Urban boundaries
MLRA_41
MLRA_40

Literature:

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Gould, F.W. 1977. Grasses of Southwestern United States. University of Arizona Press, Tucson, AZ.

Hitchcock, A.S. 1951. Manual of the Grasses of the United States. Misc. Publ. No. 200 Washington, DC; U.S. Department of Agriculture, Agricultural Research Administration.

Kearney, T.H., R.H. Peebles, J.T. Howell and E. McClintock. 1960. Arizona Flora. 2nd ed. Berkeley, CA; University of California Press.

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Wallmo, O.C. 1955. Vegetation of the Huachuca Mountains, Arizona. American Midland Naturalist. 54: 466-480.

Welsh, R.G. and R.F. Beck. 1976. Some Ecological Relationships between Creosotebush and Bush Muhly. Journal of Range Management. 29(6): 472-475.

Evaluation of Accessions of Tobosagrass from Southeastern Arizona (MLRA 41)

STUDY NUMBER: AZPMC-P-0603-CR

STUDY NUMBER: AZPMC-T-0604-CR

Description

The tobosagrass (*Pleuraphis mutica* Buckl.) initial evaluation planting (IEP) consists of 17 accessions collected from Major Land Resource Area (MLRA) 41 the Southeastern Arizona Basin and Range in southeastern Arizona and southwestern New Mexico. This area is a transition between the Chihauahuan and the Sonoran Desert regions. The plant selection study is designed to evaluate the genetic diversity among populations of tobosagrass in this area. The technology development study will evaluate and develop production techniques and a protocol for commercial use of any potential release.

Objectives of these studies are:

1. Evaluate the diversity among accessions in this collection.

2. Evaluate phenotypic characters of accessions in this collection.

3. Develop production protocols.

4. Determine yield potential of seed and forage.

5. Produce a selected release for MLRA 41.

Duration of Study: 2006 through 2010

Study Leaders: Ramona Garner and Mary Hershdorfer

Location: Tucson Plant Materials Center, Tucson, Arizona

Introduction

Tobosagrass (also known as Tobosa) is a native, rhizomatous, warm season perennial sod-forming grass (Kearney et.al., 1960). Plants may grow to 3 feet (0.9 m), but normally are 1 to 2 feet tall (0.3-0.6 m). Seed stalks are smooth and erect and 1.2 to 3 feet (30-75 cm). The leaves are up to 6 inches (15 cm) long, stiff, harsh and hairless, occurring mainly as a mass of basal leaves with only a few located along the stem. The inflorescence consists of an erect spike 1.5 to 3 inches (4-8 cm) long, broad and white, straw colored or occasionally purplish. Spikelets are upright in clusters of three with about 30 fascicles on each spike. Each fascicle is shed as a unit. (Gould, 1979). Chromosome numbers reported for tobosa are 2n = 36, 54. (Flora of North America, 2003)

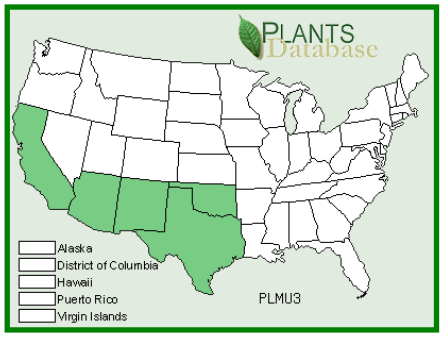


Fig. 1. Distribution of tobosagrass in North America

Tobosa is characteristically found in soils that have developed from basin fill material. These are clay soils that are tight and relatively impervious. Where surface runoff accumulates for a few days, almost pure stands forming a dense course sod may occur. Tobosa occurs on dry mesas,

sandy-loam hills and rocky slopes. On drier sites it grows in scattered stands of large, individual tufts. In Arizona tobosag grows from 2,460 to 5,906 feet (750-1800 m) (Gould, 1979).

Tobosa is important forage for livestock in the southwest. It is often maligned as forage because it is only palatable during the rainy season when it is green and succulent. During the growing season, Tobosa can produce protein of 8 to 10% and 1,000 to 1,500 lbs of forage per acre (Anderson, 1988 and Wright, 1969).

Materials and Methods

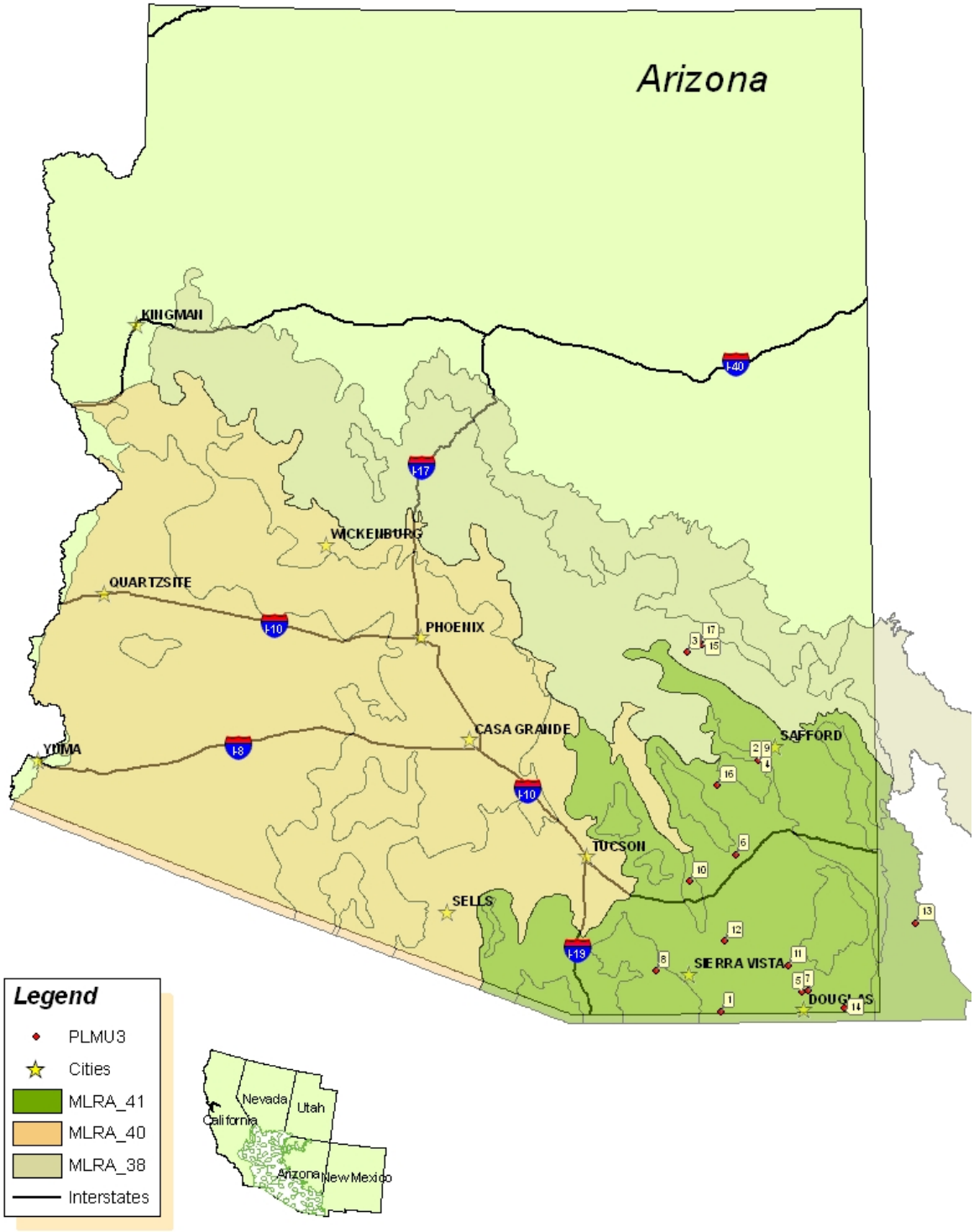
Eighteen accessions from MLRA 41 (Table 1) were grown in 35mm Jiffy forestry pellets in the greenhouse for 6 weeks. They were planted in July 2006into a randomized complete block design (RCB) with 8 replications. Each experimental unit consists of 5 individual plants. Plugs were planted into the field 18 inches apart with 40 inch centers. Extra accessions were planted at the end of the plot to fill out the field. A pre-plant application of 100 lbs/acre of ammonium phosphate (11-48-0 $[NH_4)_3PO_4]$) was applied and the planting is irrigated as needed.

Results

In future growing seasons the accessions will be evaluated for characters such as size, flowering date, germination and vigor. Agronomic techniques will be evaluated to determine yield potential of seed and forage. In 2007 the planting survived the lack of irrigation (well repair) and a late seed crop was harvested

Table 1. Accession number and collection location of 17 accessions in initial evaluation of tobosagrass.

Number	Accession Number	Collection Location	Number	Accession Number	Collection Location
1	9092489	-110.0934 31.3439	10	9092627	-110.2942 32.0792
2	9092490	-109.8287 32.7615	11	9092657	-109.6467 31.5997
3	9092491	-110.3000 33.3732	12	9092658	-110.0661 31.7411
4	9092492	-109.8287 32.7617	13	9092668	-108.8011 31.8253
5	9092522	-109.5525 31.4467	14	9092688	-109.2758 31.3556
6	9092562	-109.9865 32.2312	15	9092701	-110.1989 33.4158
7	9092575	-109.5148 31.4598	16	9092707	-110.1011 32.6214
8	9092576	-110.5189 31.5756	17	9092720	-110.2139 33.4317
9	9092577	-109.8289 32.7615			


Arizona
KINGMAN
I-40
I-17
WICKENBURG
QUARTZSITE
I-10
PHOENIX
CASA GRANDE
YUMA
I-8
I-10
SAFFORD
TUCSON
SELLS
I-19
SIERRA VISTA
DOUGLAS
Legend
PLMU3
Cities
MLRA_41
MLRA_40
MLRA_38
Interstates
Nevada
Utah
California
Arizona
New Mexico

Literature:

Anderson, D.M. 1988. Seasonal stocking of tobosa managed under continuous and rotation grazing. Journal of Range Management. 41(1):78-83.

Flora of North America, Vol 25, 2003. Ed. Barkworth, M.E., K.M. Capels, S. Long, and M.B. Piep, Oxford University Press, New York.

Gould, F.W. 1977. Grasses of Southwestern United States. University of Arizona Press, Tucson, AZ.

Hitchcock, A.S. 1951. Manual of the Grasses of the United States. Misc. Publ. No. 200 Washington, DC; U.S. Department of Agriculture, Agricultural Research Administration.

Kearney, T.H., R.H. Peebles, J.T. Howell and E. McClintock. 1960. Arizona Flora. 2nd ed. Berkeley, CA; University of California Press.

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Wright, H.A. 1969. Effect of spring burning on tobosa grass. Journal of Range Management. 22 (6) : 425-427.

Camp Creek Restoration Project: A Preliminary Year of Activities

STUDY NUMBER: AZPMC-T-0704-CR

STUDY NUMBER: AZPMC-0705-CR

Verbena, a desirable species for restoration

At the request of the Tonto National Forest, the Tucson PMC agreed to assist with a restoration project for the Forest. The area in question is the Camp Creek drainage, a riparian drainage north of Cave Creek, Arizona, which burned in a catastrophic fire in 2005. Following the fire, several invasive species, in particular Vinca (*Vinca major*), and small patches of several others including Giant reed (*Arundo donax),* Tree of heaven *(Ailanthus altissima)* and Jerusalem thorn *(Parkinsonia aculeate),* increased within the creek's channels and arid slopes. In order to remove the Vinca and the other nonnative invaders without increasing erosion, appropriate native ground cover was proposed be planted in place of the infestation. The first step was to choose appropriate replacement plants for the Camp Creek drainage- those that produce good ground cover for soil stability, and a mixture of common species that have proven themselves adapted to the area as well as attractive species that would be acceptable to home owners. Vinca, attractive with purple flowers and an abundance of vegetation, was originally planted in the area as an ornamental, and the Forest feared negative public backlash at its removal. The Forest planned a series of public relation meetings to discuss the project, and at one of the meetings homeowners were invited to attend a field trip to visit some of the proposed restoration sites and to address specifics of the project on site with members of the Forest and the Tucson PMC. In spring 2007 the field trip attracted several home owners, all of which appeared interested and curious about the project. Stems of several species were collected to experiment with pole plantings for the containerized plantings in the future.

Patti Fenner of the Tonto National Forest, shin deep in Vinca

In May, a crew of seed collectors took another tour of sites within the drainage to locate good stands of native vegetation from which to make seed collections. Attendees of this tour included the Forest, the PMC, interested individuals from the Phoenix Botanical Gardens, and several volunteers including a few Camp Creek homeowners, to learn about species in the area and how to collect seed of desirable species. A number of collections were made that day, and in the months following, the Forest, a hired contractor (one of the original volunteers), and two other dedicated volunteers who frequently visited these areas and other sites throughout the drainage, making additional collections and checking for times of ripening seed. Several species required multiple site checks in order to be present for optimum timing of seed maturation and collection. The goal of the collections was to harvest seed from diverse species, and from multiple plants and locations of each species, in order to increase genetic diversity. By the end of the fall of 2007, over 50 collections of over 30 species had been collected (Table 1), each located with GPS. The collections were mailed to the PMC for cleaning and storage.

A group of volunteers take notes in preparation for seed collections

In order to determine the number of plants that could be grown for this project from the seed collections, the PMC cleaned the seed, weighted it and estimated number of seed using available references or using an automated seed counter. The predicted total number of plants that could be grown from these seed stores was determined by the following simple calculation:

Number of plants = (# seed) multiplied by (25% seed viability) divided by (4 seed/pot)
The estimated number of seed is multiplied by 25% seed viability, a typical expectation for wildland seed collections, and then divided by 4, as each pot should be sowed with at least 4 seeds in case of poor seed quality or other complications in planting. In other words, the predicted number of plants that could potentially be grown for each species was calculated by dividing the estimated number of seed by 8.

This simple calculation was useful to predict the number of plants that could be grown, but it also demonstrated to the seed collectors which species so far would likely be dominant in the restoration, which species would unlikely be represented due to lack of seed, and illuminated certain desirable species worthy of additional seed collection trips. As a result of this information, several more collections were made of certain species the following spring.

Golden columbine, a desirable restoration species

Before any restoration project can take place in Camp

Creek, the Forest is responsible for the removal of Vinca and other invasive species. Once given permission to spray herbicides in the forest, they will ideally conduct weed control for at least two growing seasons. Once the Vinca has been removed, the PMC and a nonprofit nursery in Tucson plan to grow several thousands of plants for the eventual restoration.

Table 1. Camp Creek Seed Collection Quantities

Species	Common Name	post-clean weight (g)	approx. # of seeds	approx. # of plants[1]
Aquilegia chrysantha	Golden columbine	18.25	Millions	X
Aquilegia chrysantha	Golden columbine	6.46	Millions	X
Aristolochia watsonii	Watson's dutchman's pipe	2.91	~ 400	25
Clematis drummondii	Drummond's Clematis	30.18	~ 10,000	X
Datura inoxia	Datura	10.38	~ 800	50
Glandularia bipinnatifida	Dakota mock vervain	1.26	~ 400	25
Glandularia bipinnatifida	Dakota mock vervain	5.41	~ 1000	62
Glandularia gooddingii	Goodding's verbena	0.87	~ 2000	125
Glandularia gooddingii	Goodding's verbena	0.59	~ 1500	93
Ipomoea hederifolia	Scarlet creeper	3.26	~ 300	18
Ipomoea hederifolia	Scarlet creeper	4.15	~ 500	31
Ipomea sp.	Morning glory sp.	1.24	77	4
Janusia gracilis	Slender janusia	17.67	~ 10000	X
Janusia gracilis	Slender janusia	15.72	~ 10000	X
Juncus xiphioides	Irisleaf rush	1.17	~ 100,000	X
Maurandella antirrhiniflora	Roving sailor	0.43	~ 2000	125

Species	Common Name	post-clean weight (g)	approx. # of seeds	approx. # of plants[1]
Maurandella antirrhiniflora	Roving sailor	0.21	134	8
Maurandella antirrhiniflora	Roving sailor	2.77	1900	118
Maurandella antirrhiniflora	Roving sailor	2.61	1669	104
Mimulus guttatus	Monkey flower	0.06	Lots	X
Mimulus guttatus	Monkey flower	0.03	Lots	X
Mimulus guttatus	Monkey flower	5.31	Billions	X
Mirabilis albida	White 4 o'clock	0.39	35	2
Mirabilis albida	White 4 o'clock	0.74	60	3
Mirabilis albida	White 4 o'clock	0.72	60	3
Mirabilis coccinea	Scarlet four o'clock	1.6	~ 150	9
Mirabilis coccinea	Scarlet four o'clock	0.15	10	1
Mirabilis multiflora	Colorado four o'clock	0.16	8	1
Muhlenbergia rigins	Deer grass	15.21	Millions	X
Northoscordum texanum	Texas false garlic	0.17	50	3
Oenothera caespitosa	Tufted evening primrose	9.66	27686	X
Oenothera caespitosa	Tufted evening primrose	7.3	20922	X

Species	Common Name	post-clean weight (g)	approx. # of seeds	approx. # of plants[1]
Oligoneuron sp (rigidum?)	Goldenrod	1.21	Thousands	X
Oligoneron sp (rigidum?)	Goldenrod	2.98	Millions	X
Penstemon pseudospectabilis	Desert penstemon	14.83	Millions	X
Penstemon pseudospectabilis	Desert penstemon	14.06	Millions	X
Penstemon pseudospectabilis	Desert penstemon	16.9	Millions	X
Phaseolus angustissimus	Slimleaf bean	0	1	<1
Phaseolus angustissimus	Slimleaf bean	1.17	~ 50	3
Phaseolus angustissimus	Slimleaf bean	1.99	~ 100	6
Rhus microphylla	Little leaf sumac	4.93	~ 30	1
Rhus ovata	Sugar sumac sumac	20.62	~ 150	9
Rhus trilobata	Skunkbush sumac	116.71	Hundreds	X
Rhus trilobata	Skunkbush sumac	182.4	Hundreds	X
Rhynchosia senna	Texas snoutbean	<0.10	4	<1
Rhynchosia senna	Texas snoutbean	0	2	<1
Salix gooddingii	Goodding's willow	0.13	~ 500	31
Salvia columbariae	Chia	0.3	~ 130	8

Sphaeralcea coccinea	Globemallow	1.54	~ 2000	125
Solanum xanti	Chaparral nightshade	9.03	~ 400	25
Vitis arizonica	Canyon grape	100.28	~ 1000	62
Vitis arizonica	Canyon grape	95.41	~ 1000	62
Unknown (says Salvia)		7.72	~ 10000	X

[1]X = innumerable plants can be grown from this collection

Rows highlighted in grey demonstrate collections that have expected plant values of zero to none.